Polar Ice Sheets Monitoring related Global Environmental Change using GCOM-W AMSR2

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National Institute of Polar Research

Contents of this presentation

Antarctic Research
- Related to JARE
- Ice Sheet, warming and cooling regimes
- Melting of ice shelf
- Break off of fast ice

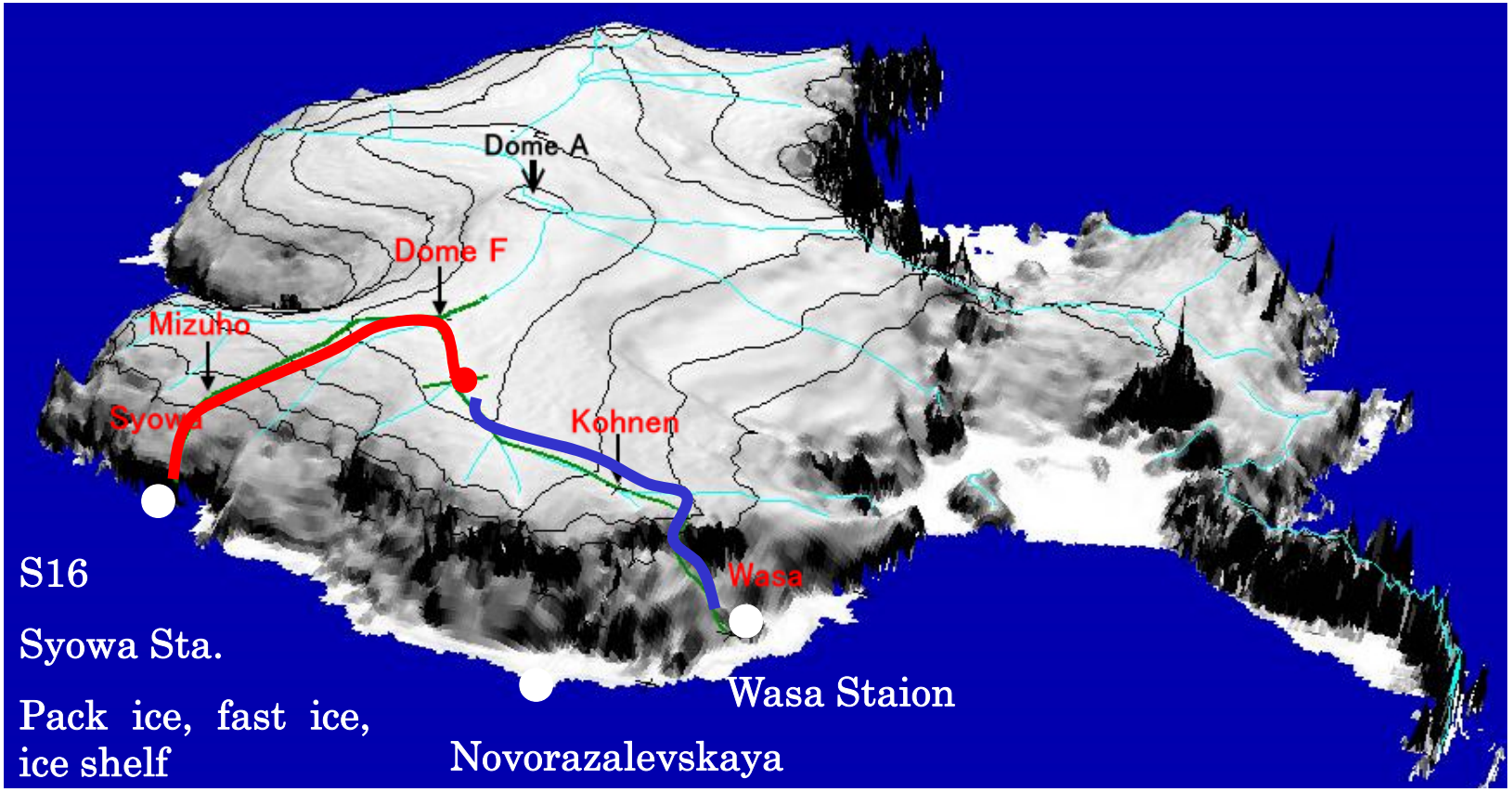
Arctic Research
- New Japanese Arctic Climate Research Project
- Greenland Ice Sheet Research
- Surface melting and glacier dynamics
- Interdisciplinary study in the Arctic

Microwave data for the Antarctic Research

We try to find characteristics of microwave data from polar snow and ice and analyze relationships with physical parameters, then try to obtain climatological informations:

- **Temperature**
  - **annual mean/short term temperature variation**
- **Snow accumulation**
  - **annual accumulation rate/short term change**
- **Surface conditions**
  - **snow properties**
  - **dominant wind field**
  - **condensation (surface hoar formation)**
  - **surface melting.**

Field Observation Area



Japanese Antarctic Research Expedition (JARE) since 1957

- Syowa Station :wintering station, Dome F, Mizuho
- Transport: icebreaker Shirase through pack ice, fast ice
- Monitoring, detecting event

Microwave channels:

6 GHz: *snow-temperature and layering*;
large penetration depth: *very stable in time*;
difference of polarization: *number of layers*,

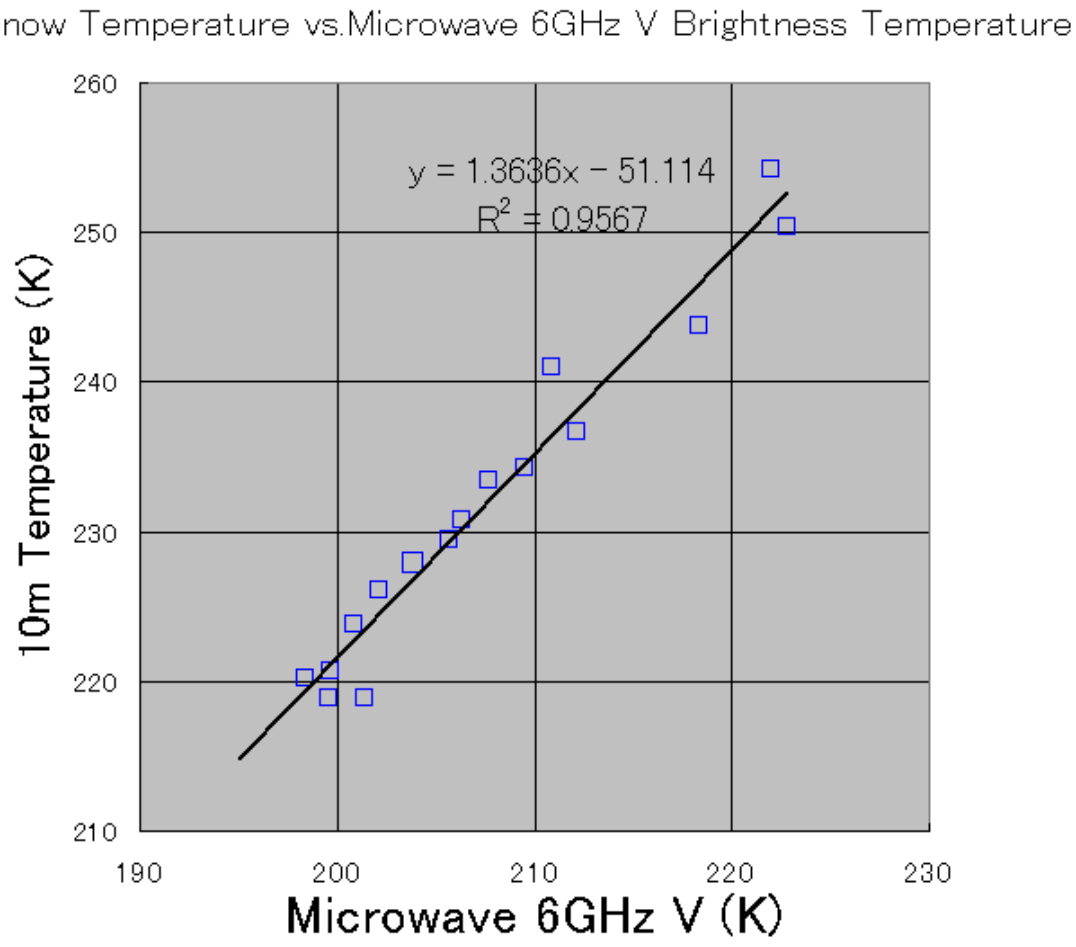
36 GHz: *highly sensitive to the crystal size* (&shape) *and the temperature*;
small penetration depth *highly changing*.
detect snow temperature changes;
interaction with crystal size, density and surface roughness.

18 GHz: *depends on all the snow-cover parameters*
large penetration depth *less quickly than 36GHz*

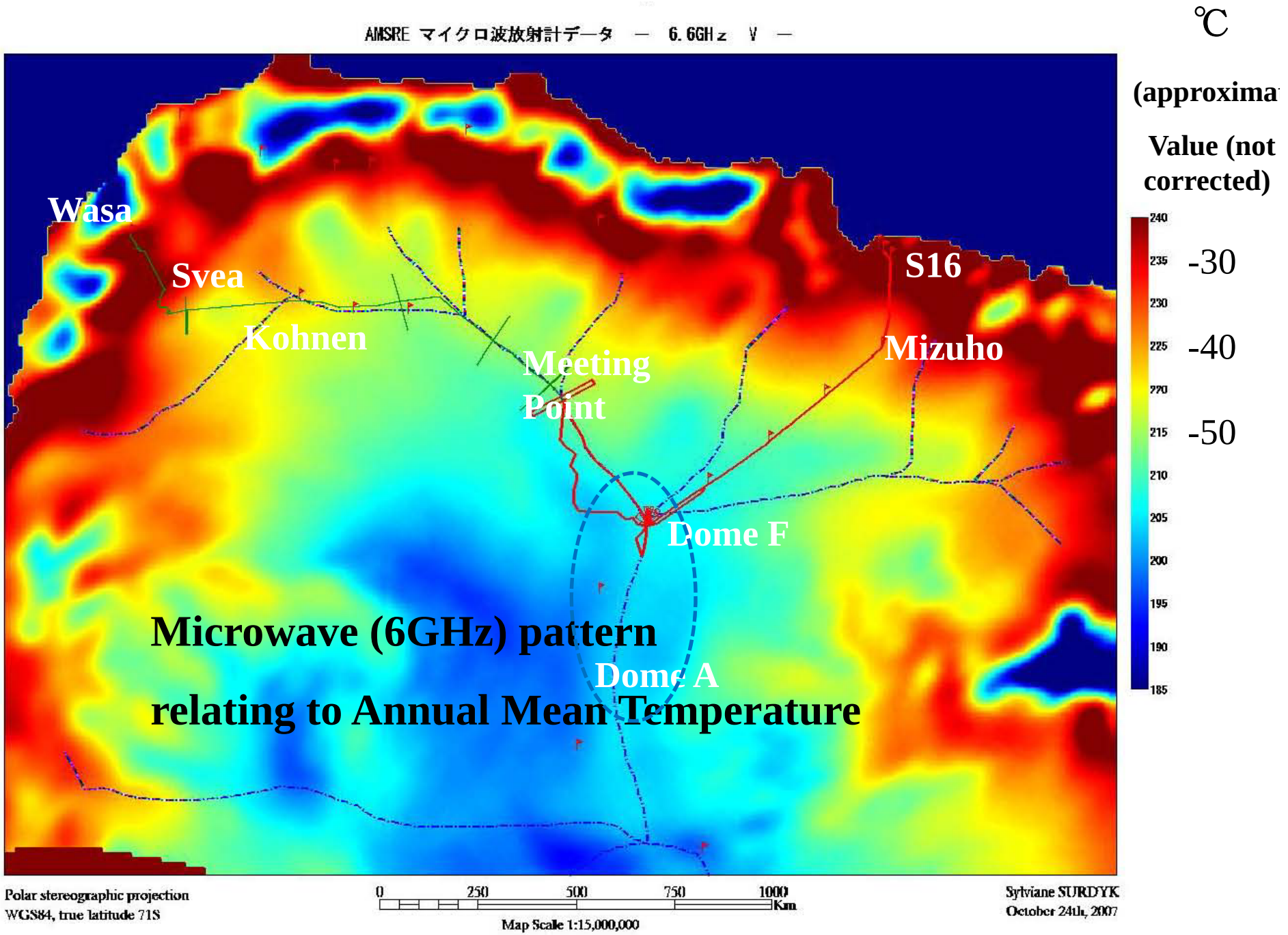
Microwave and
Annual mean temperature

Shallow drillings were available at 16 points and snow temperatures at 10m depth were collected. Microwave data at the drilling sites show good correlations.

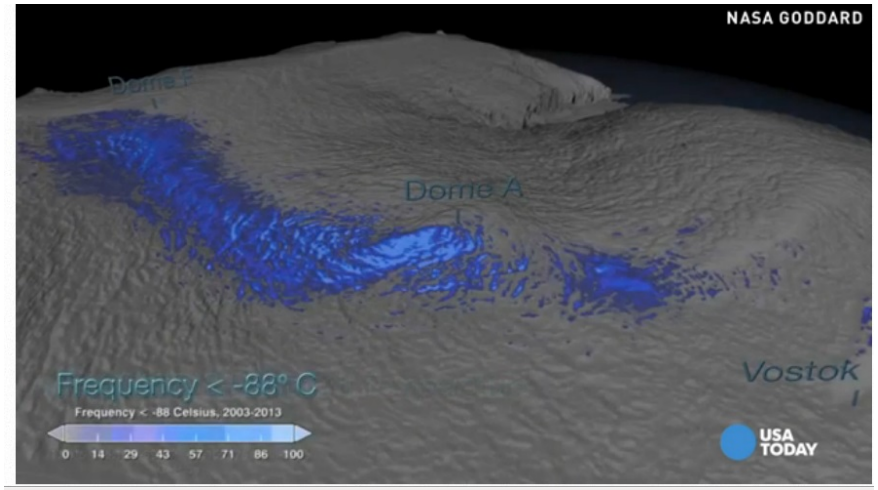
This relationship can be available over wide area of the ice sheet.



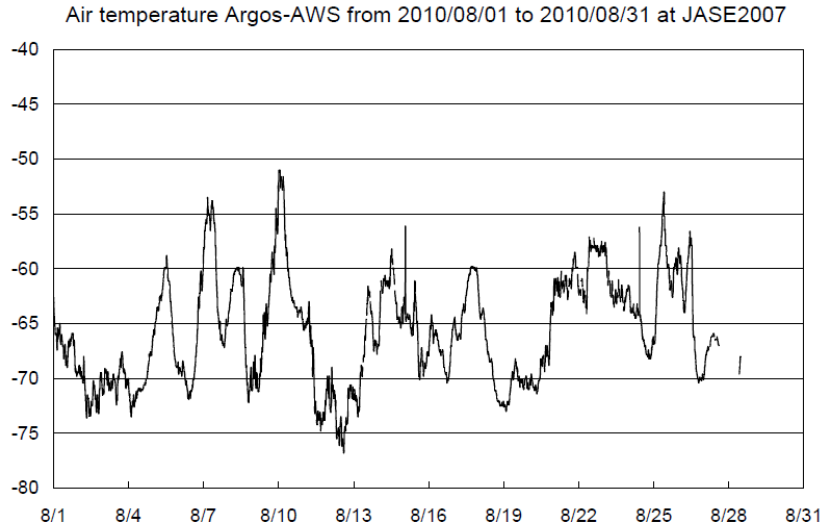
MW Averaged > 40km


AMSRE マイクロ波放射計データ — 6.6GHz V —
℃
(approxima
Value (not corrected)
240
235
230
225
220
215
210
205
200
195
190
185
-30
-40
-50
Wasa
Svea
Kohnen
Meeting Point
S16
Mizuho
Dome F
Dome A
Microwave (6GHz) pattern
relating to Annual Mean Temperature
Polar stereographic projection
WGS84, true latitude 71S
0
250
500
750
1000
Km
Map Scale 1:15,000,000
Sylviane SURDYK
October 24th, 2007

Temperature minimum in the Antarctica -93℃ Aug. 10, 2010
AGU2013, Ted Scambos

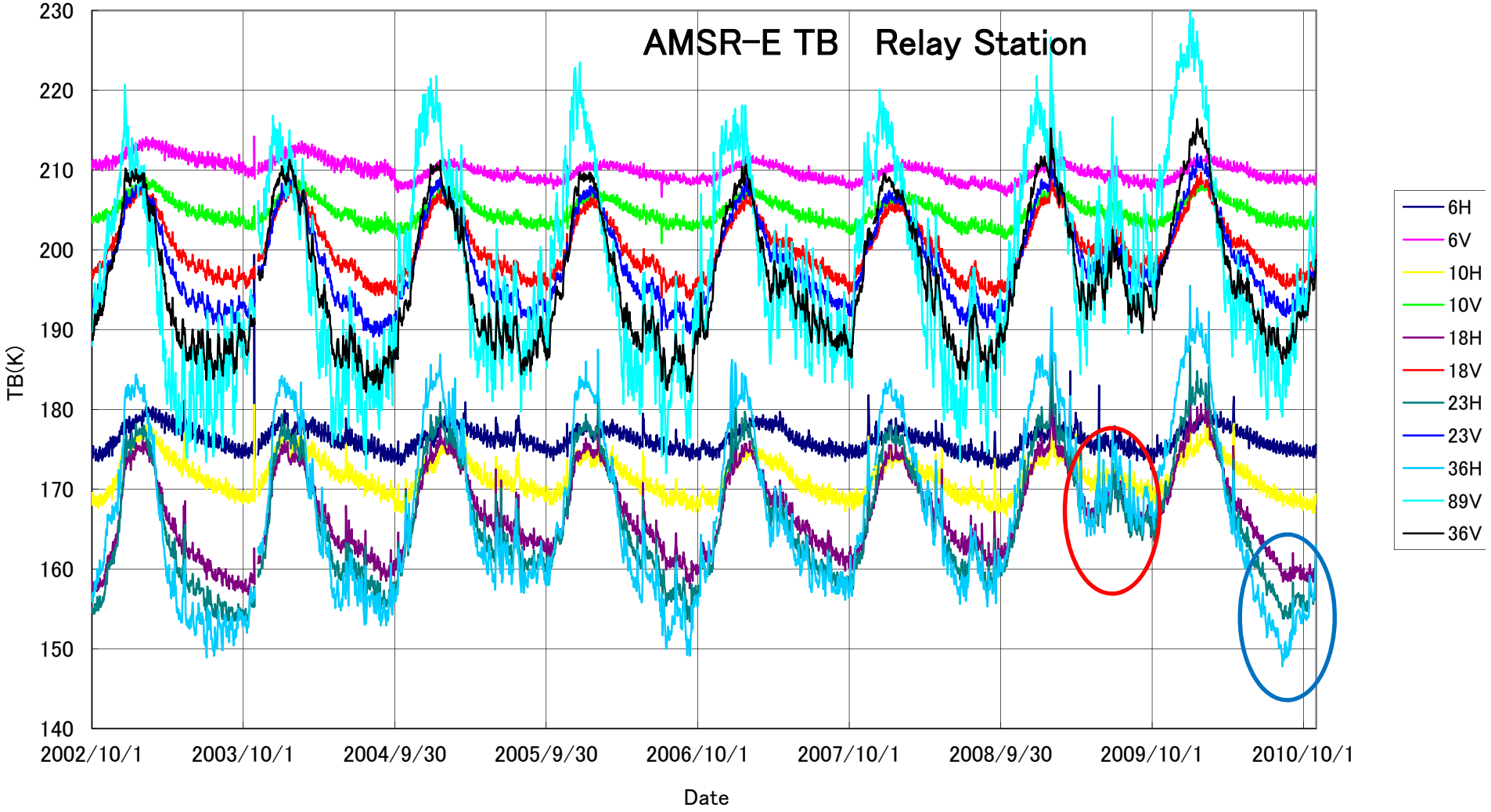


Surface temperature retrieved by Landsat



Screen height temperature
AWS on the ridge near Dome F

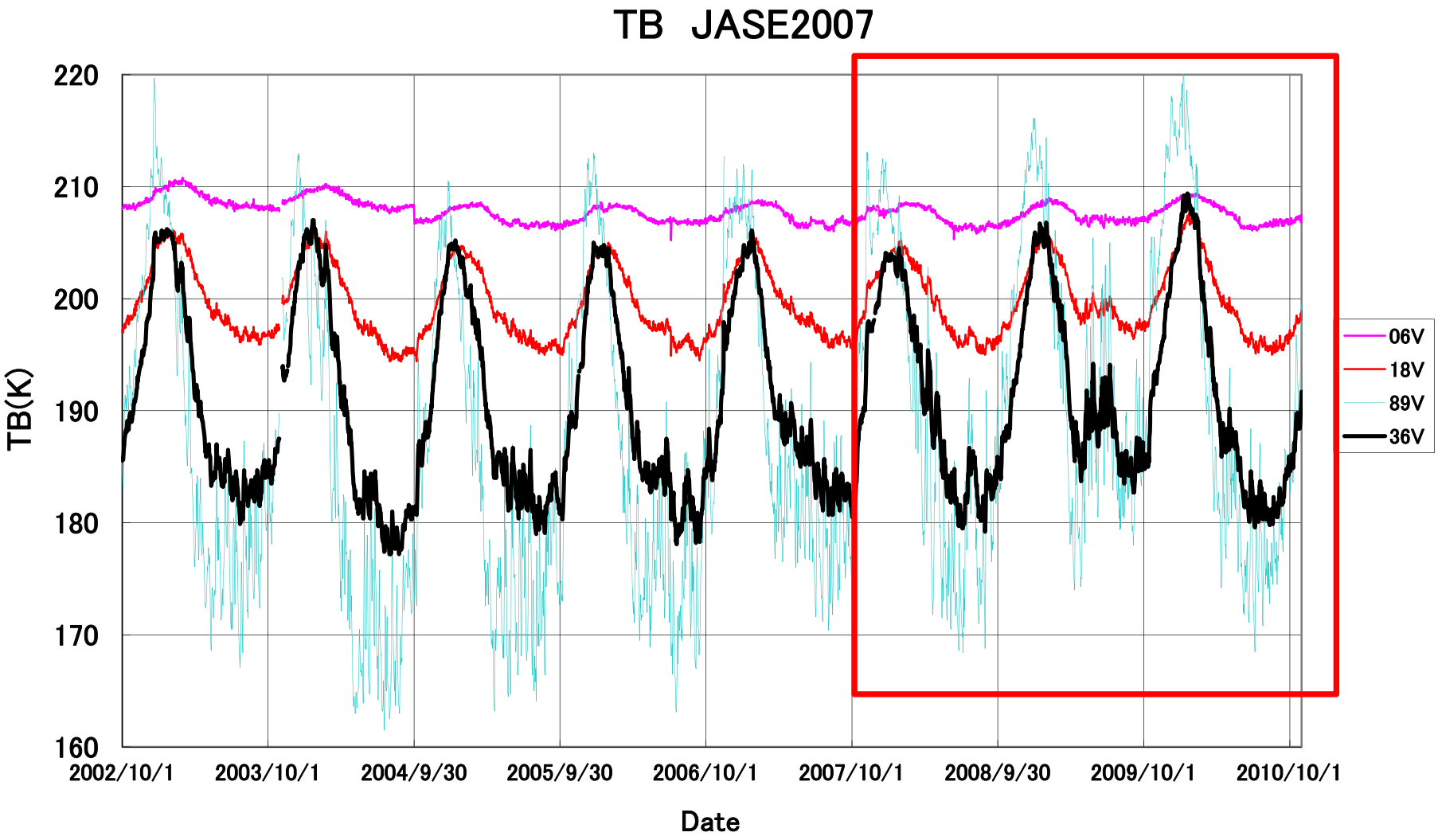
Antarctic inland Cooling and Warming Regimes



Cooling: radiative cooling

Warming: warm and moist air advection

Antarctic inland Cooling and Warming Regimes
Dome F – Ridge area



Cooling: radiative cooling

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Antarctic inland Cooling and Warming Regimes
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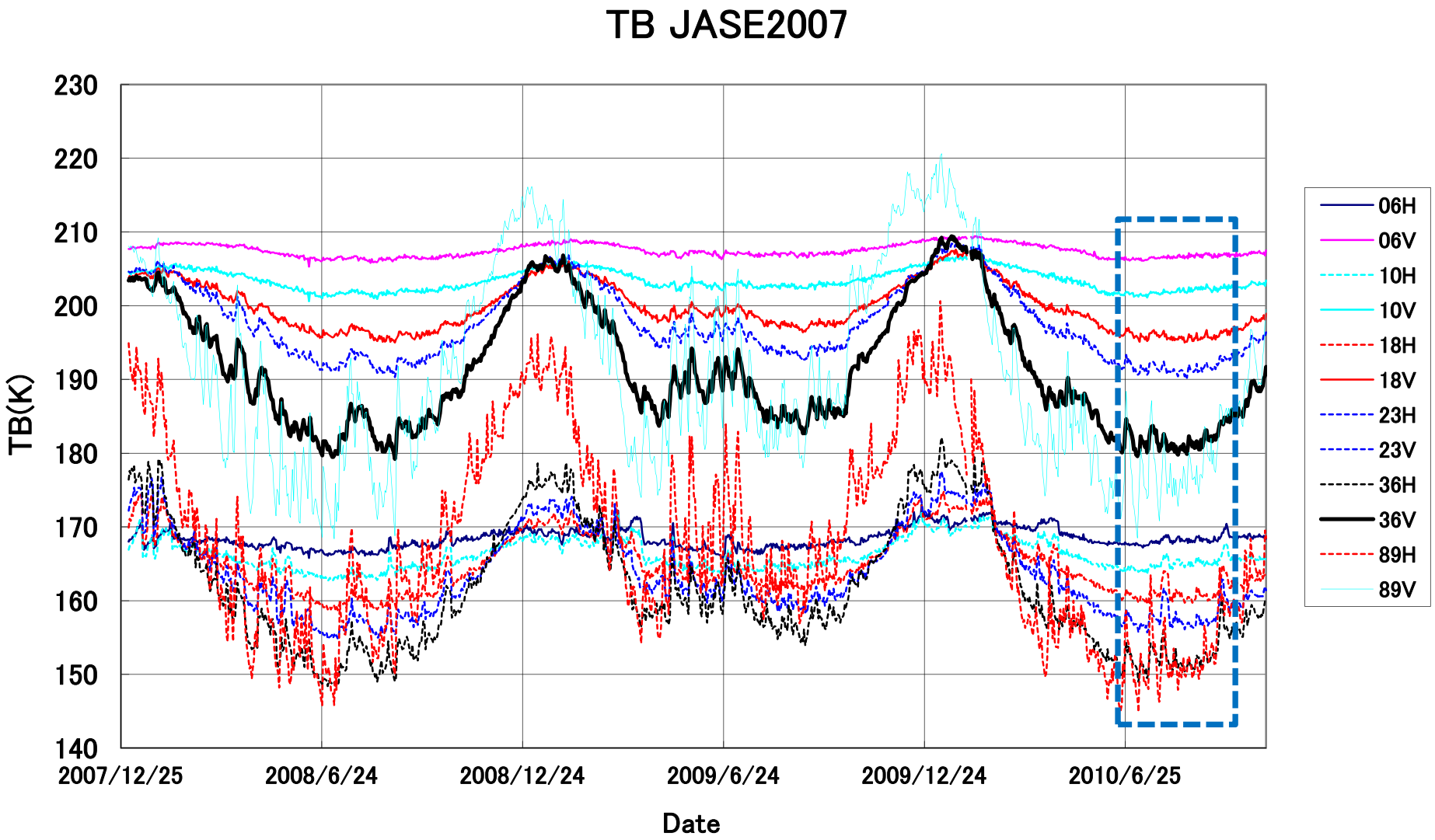
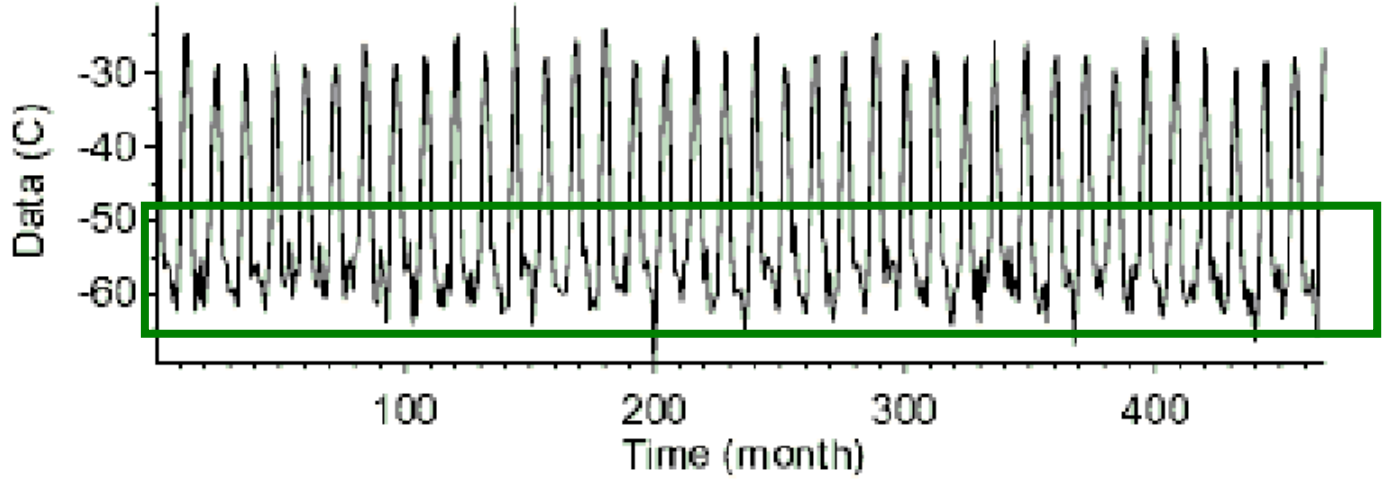
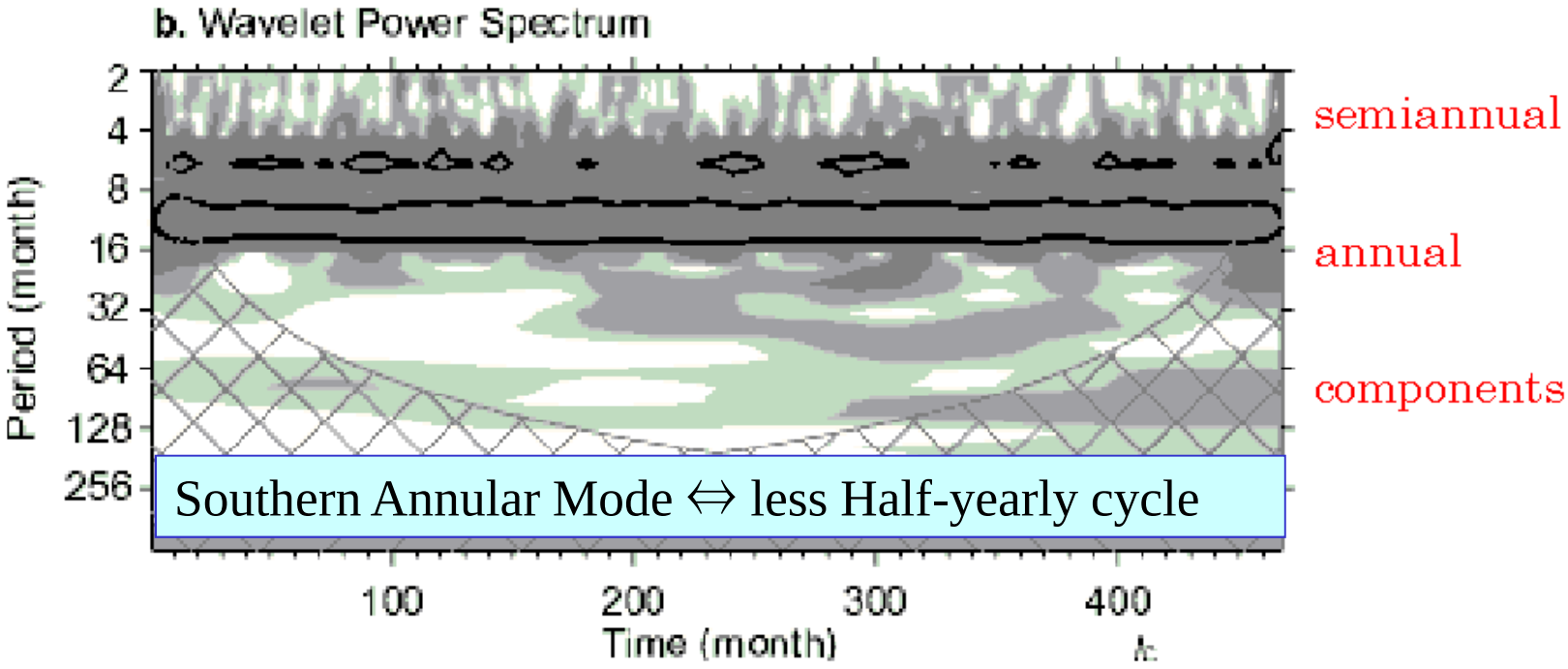


Quiet winter / less disturbances in 2010

Climatological trrend?
Half yearly-cycle in air temperature SP





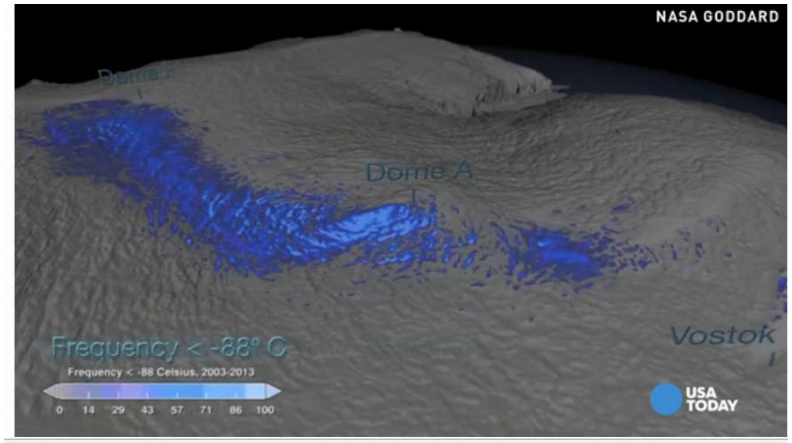
semiannual

annual

components

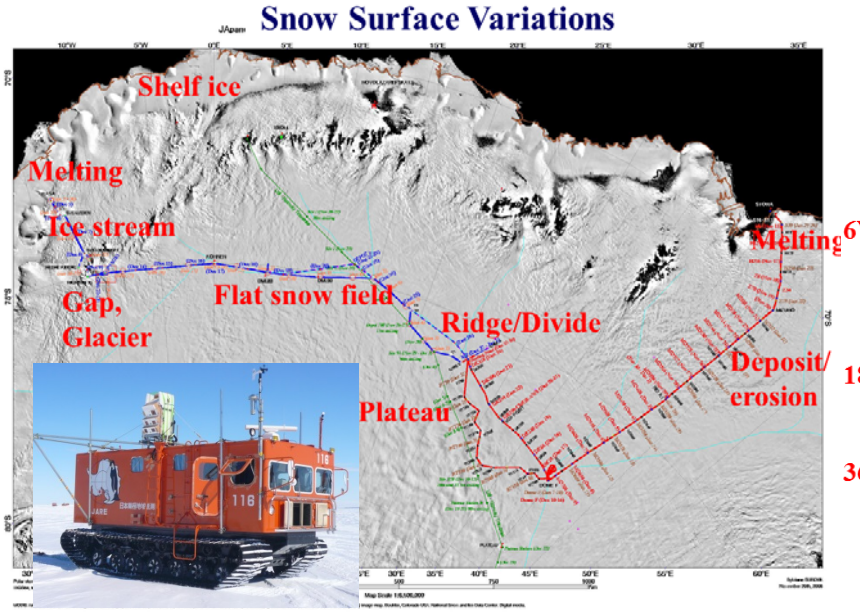
Southern Annular Mode ⇔ less Half-yearly cycle

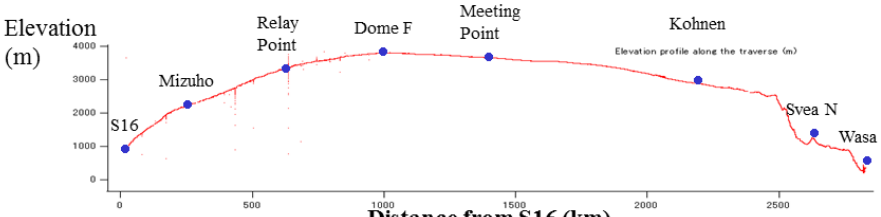
Cooling : temperature/regional temporal emissivity change

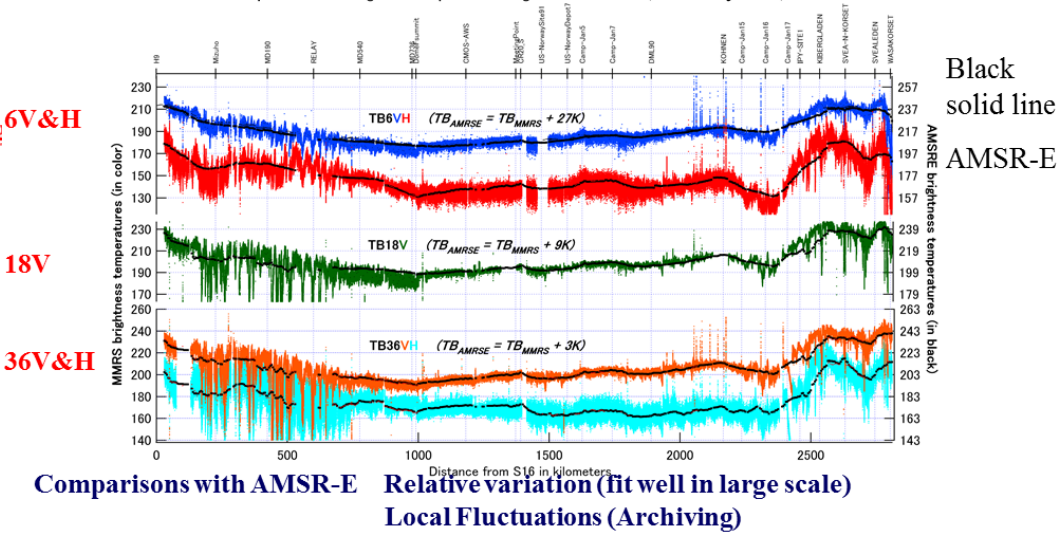


Surface temperature retrieved by Landsat (Scambos, AGU2013)

Patch-like and short term occurring frequency



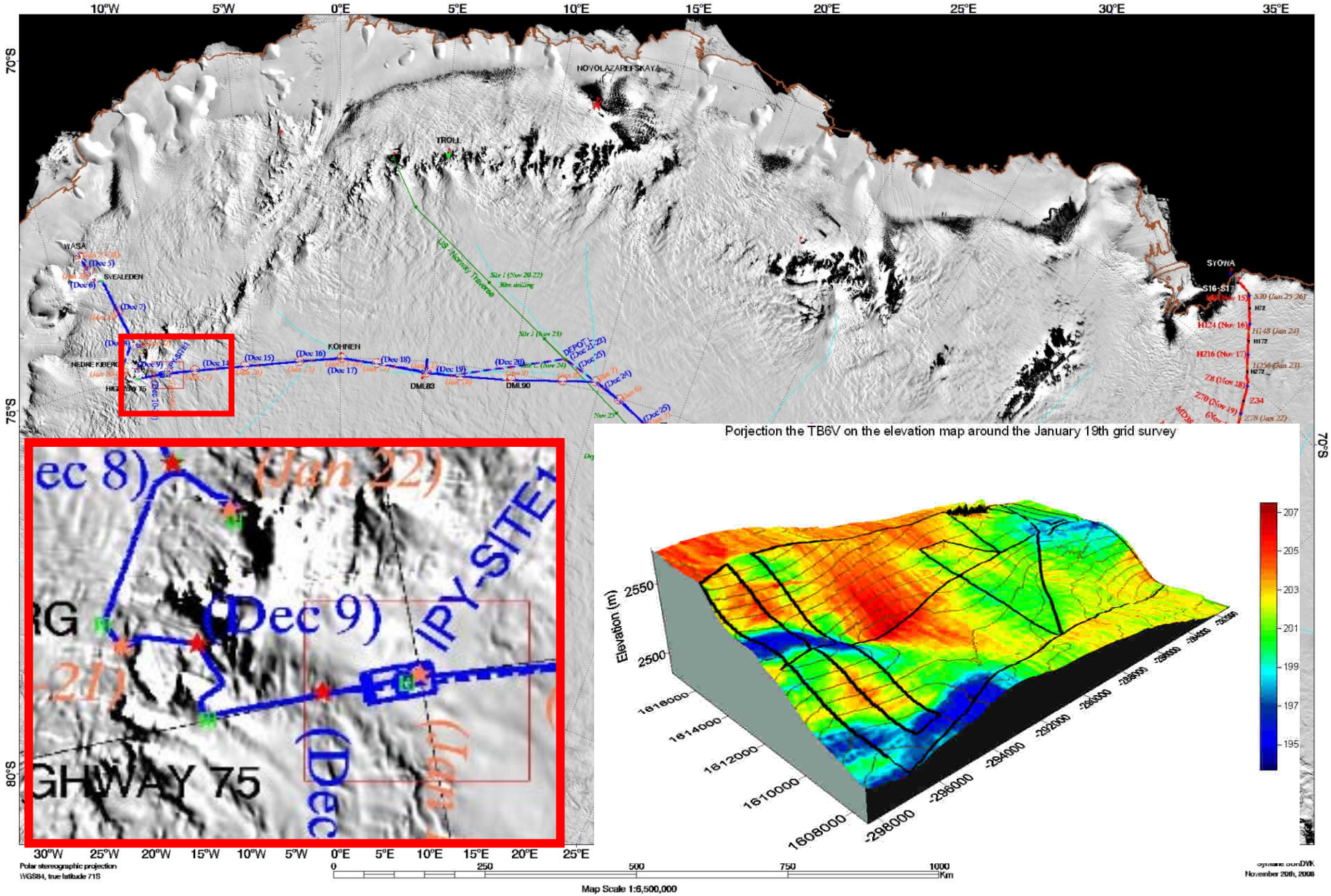




Black solid line AMSR-E

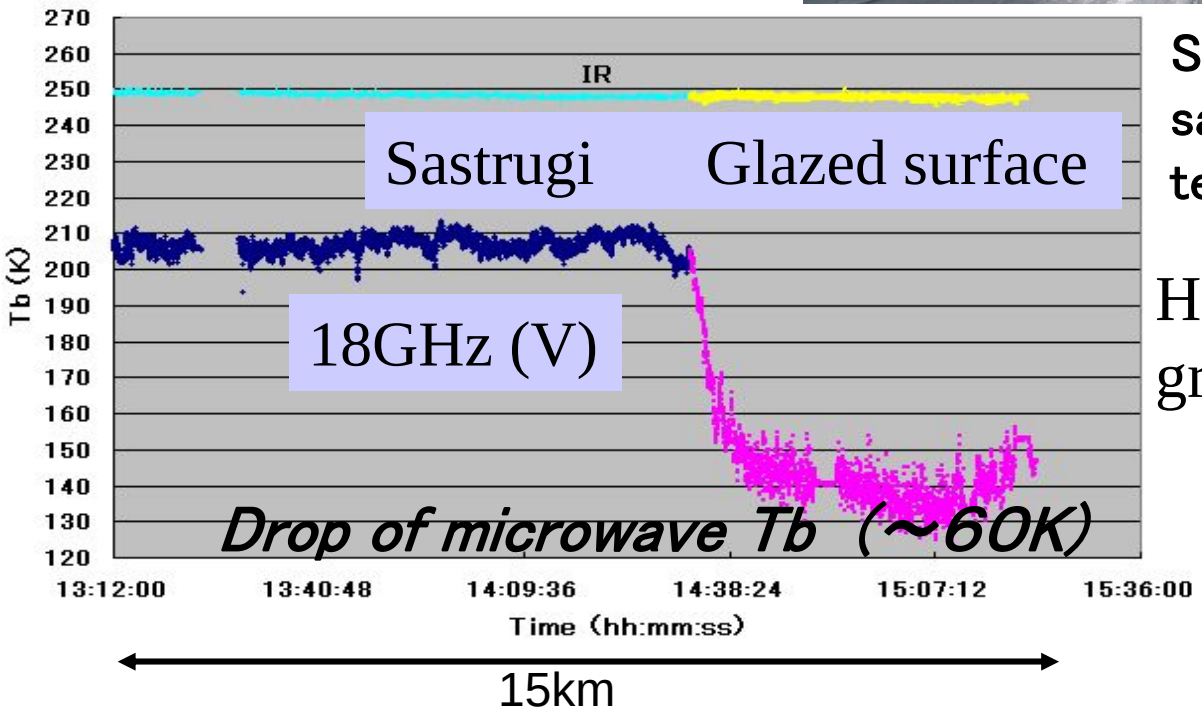
Comparisons with AMSR-E **Relative variation (fit well in large scale)**
Local Fluctuations (Archiving)

JApanese Swedish Antarctic Expedition traverse (November 2007 to January 2008)



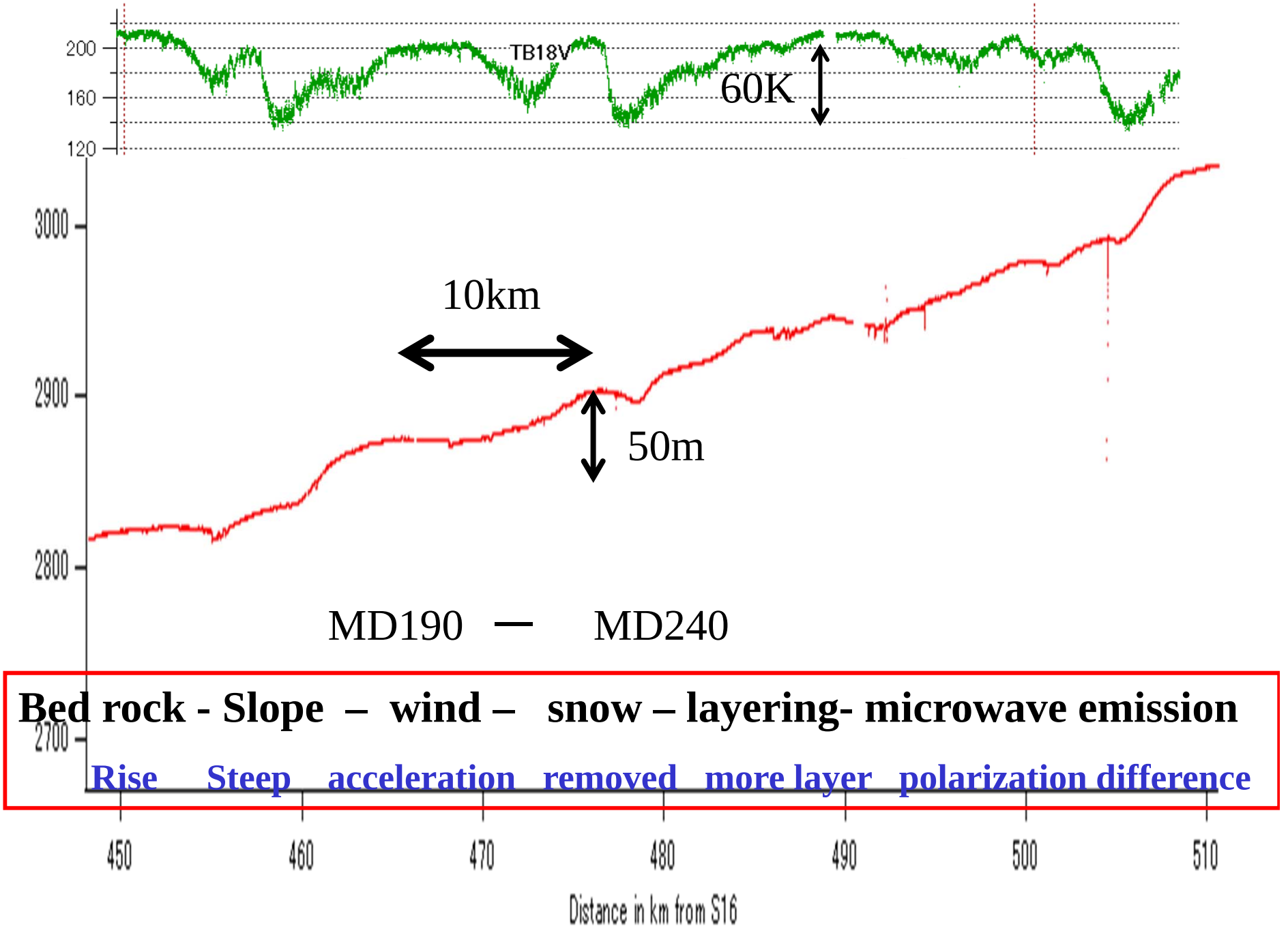
MODIS Antarctic Mosaic. Acknowledgement to: Haran, T., J. Bohlander, T. Scambos, T. Painter, and M. Fahnestock compilers. 2005, updated 2006. MODIS mosaic of Antarctica (MOA) image map. Boulder, Colorado USA: National Snow and Ice Data Center. Digital media.

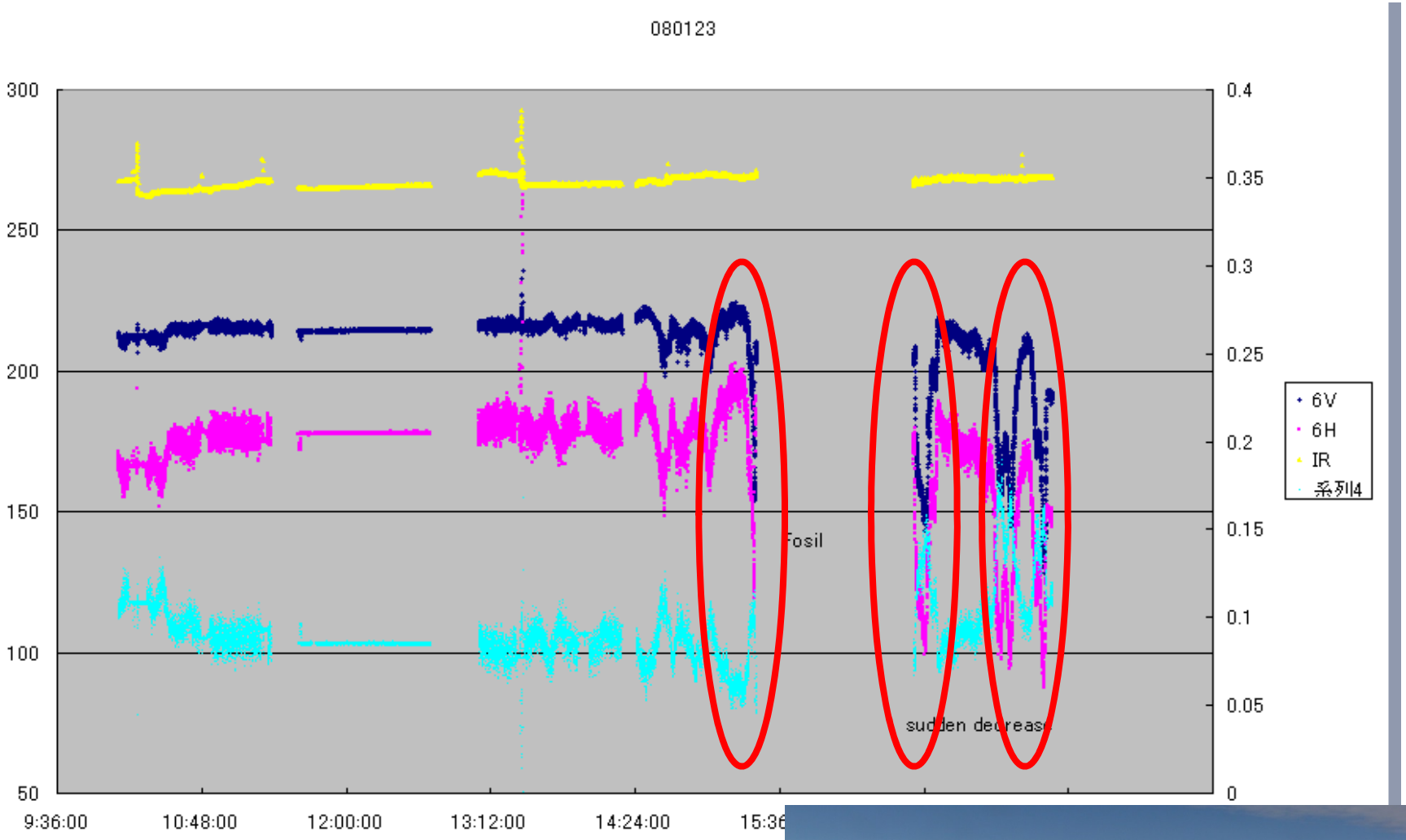
Area of Low emission (Glazed surface)



Stable infrared (almost same surface temperature)

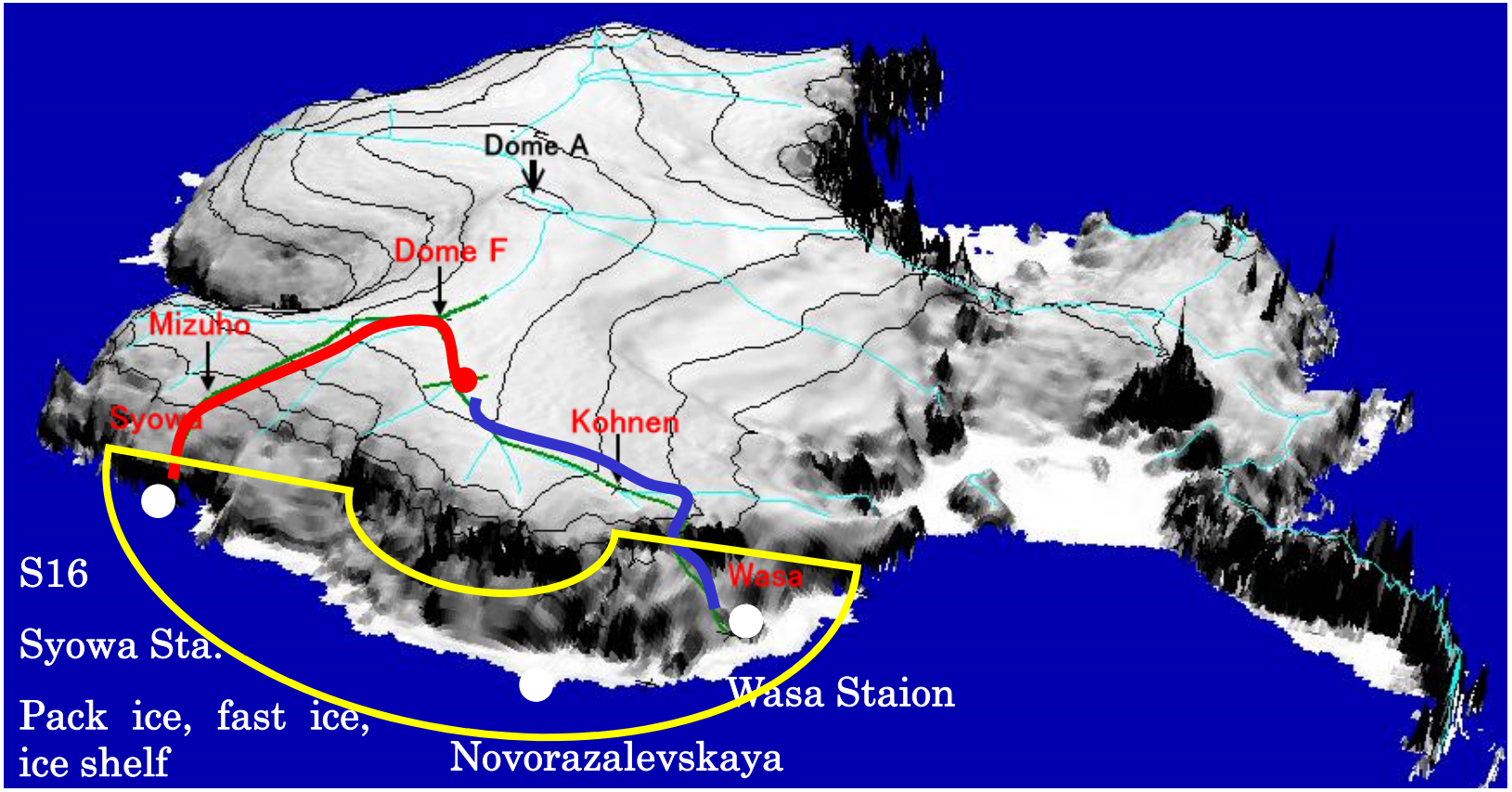
Hard surface with large grain and hard layer


TB18V
200
160
120
60K
3000
2900
2800
2700
10km
50m
MD190 — MD240
Bed rock - Slope – wind – snow – layering- microwave emission
Rise Steep acceleration removed more layer polarization difference
450
460
470
480
490
500
510
Distance in km from S16



Sudden drop of microwave emission on the snow slope. No visible differences on the surface snow. Ice lens in the deep layer?

Focusing Coastal Area



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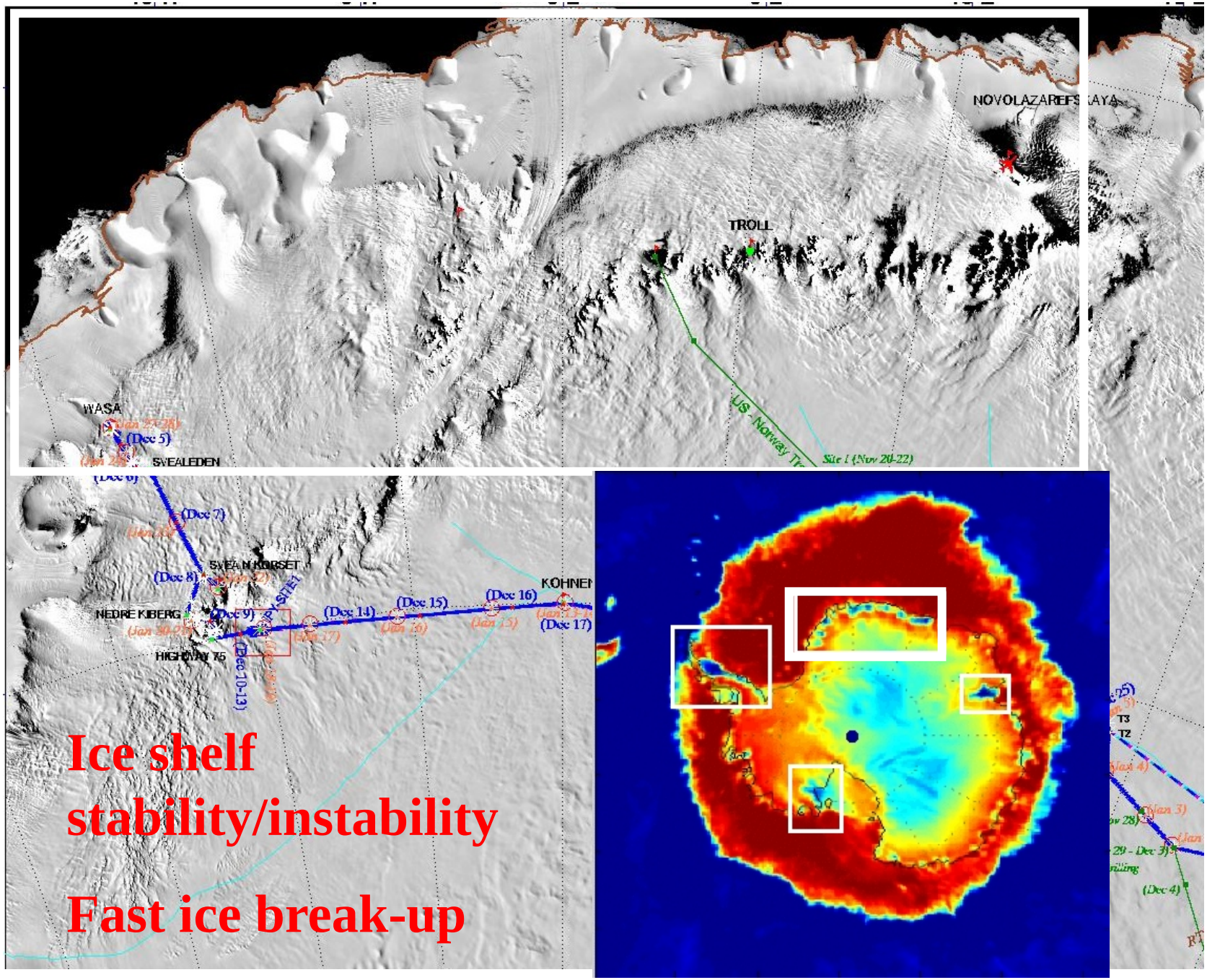
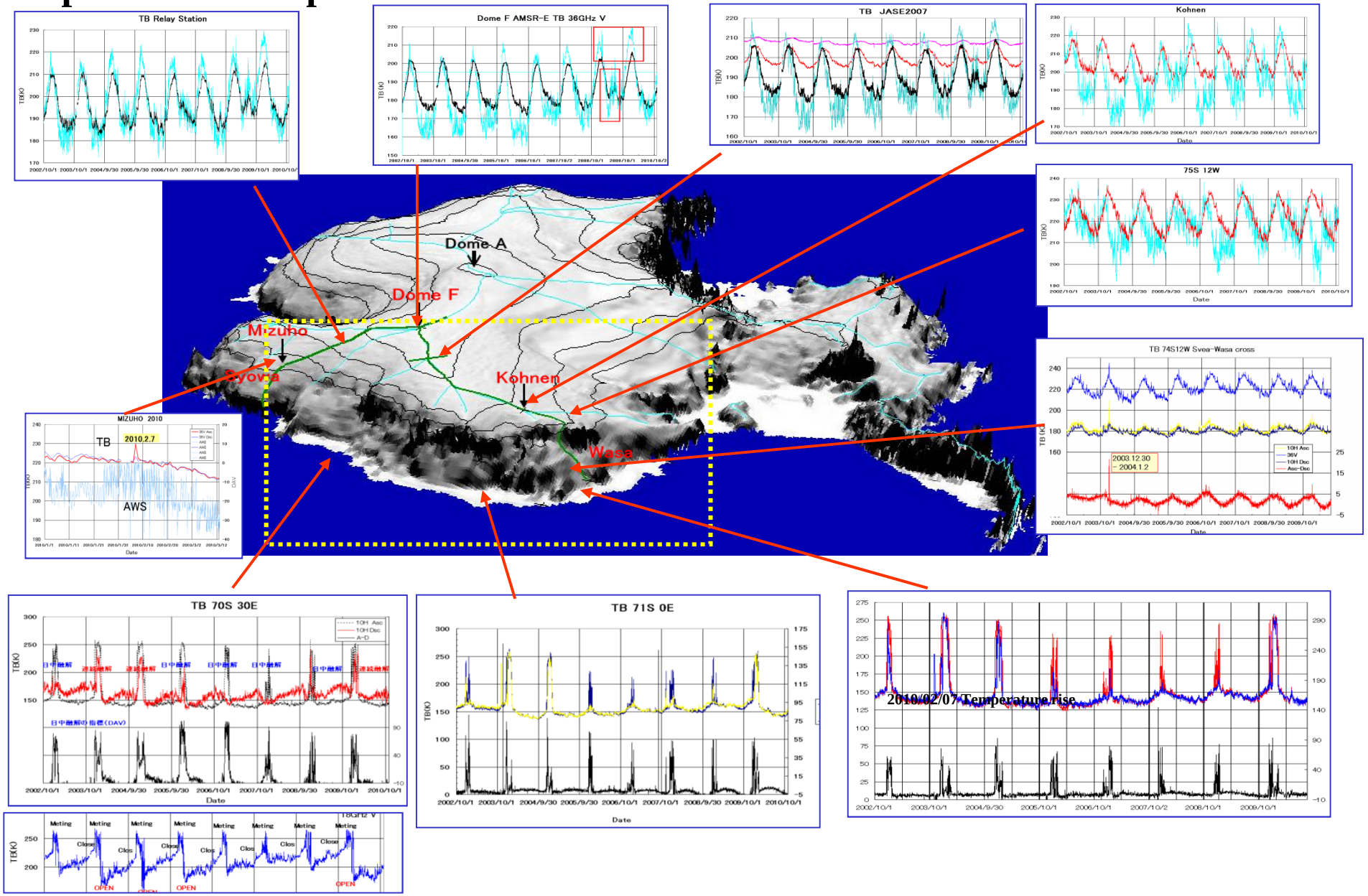
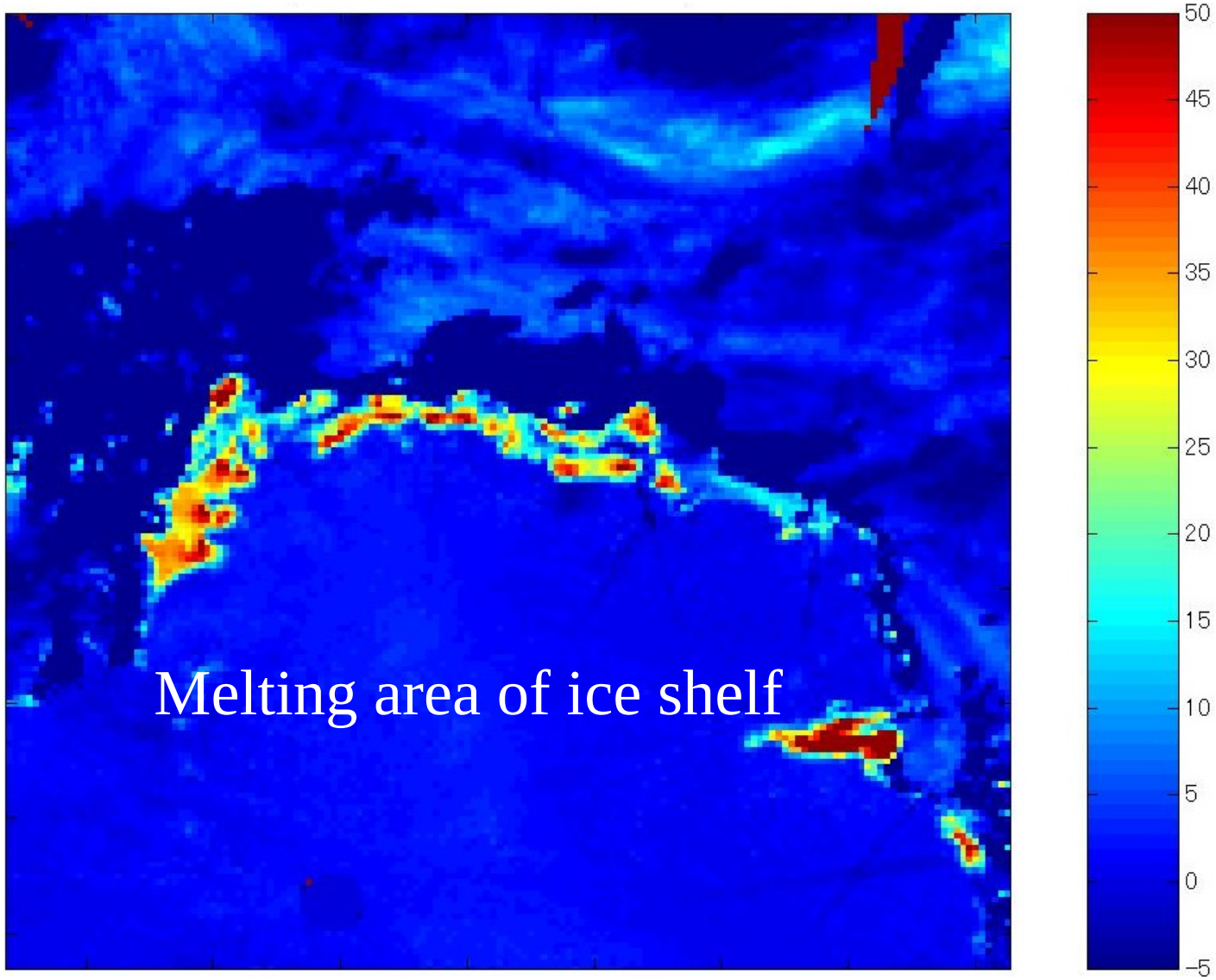

NOVOLAZAREFS AYA
TROLL
US - Norway Tr
Site 1 (Nov 20-22)
WASA
(Dec 5)
SVEALEDEN
(Dec 7)
SVEA N KORSET
(Dec 8)
NEDRE KIBERG
(Dec 9)
HIGHWAY 75
(Dec 10-13)
(Dec 14)
(Dec 15)
(Dec 16)
(Dec 17)
KOHNEN
T3
T2
(Dec 4)
Ice shelf stability/instability
Fast ice break-up

AMSR-E information along Traverse Route and surrounding area

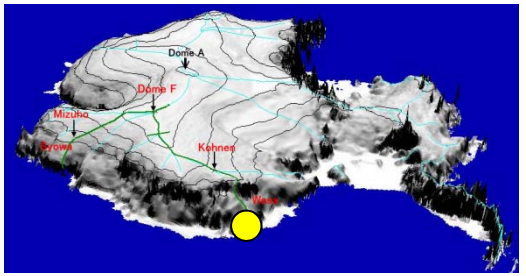
Spatial and Temporal variations

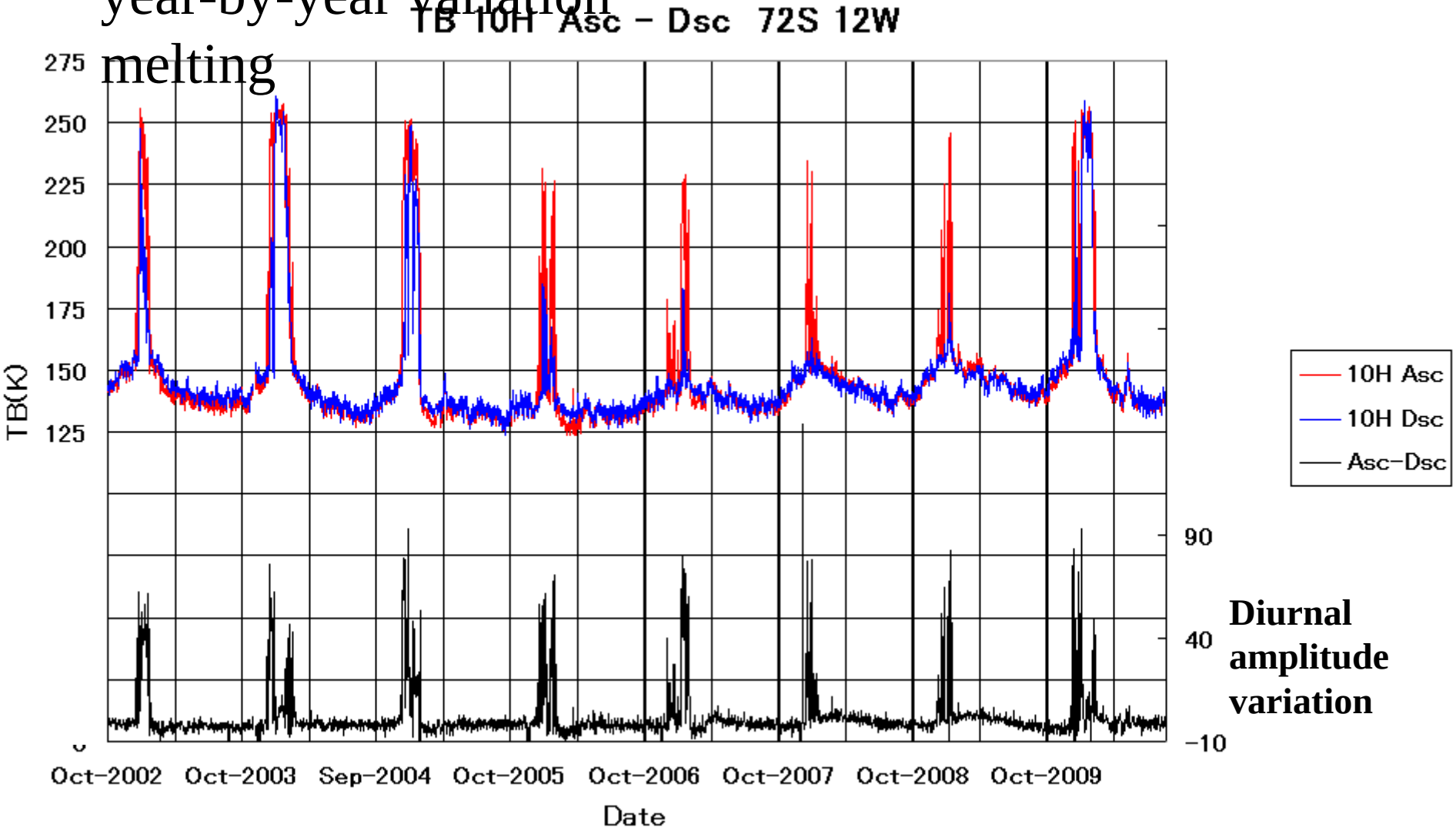




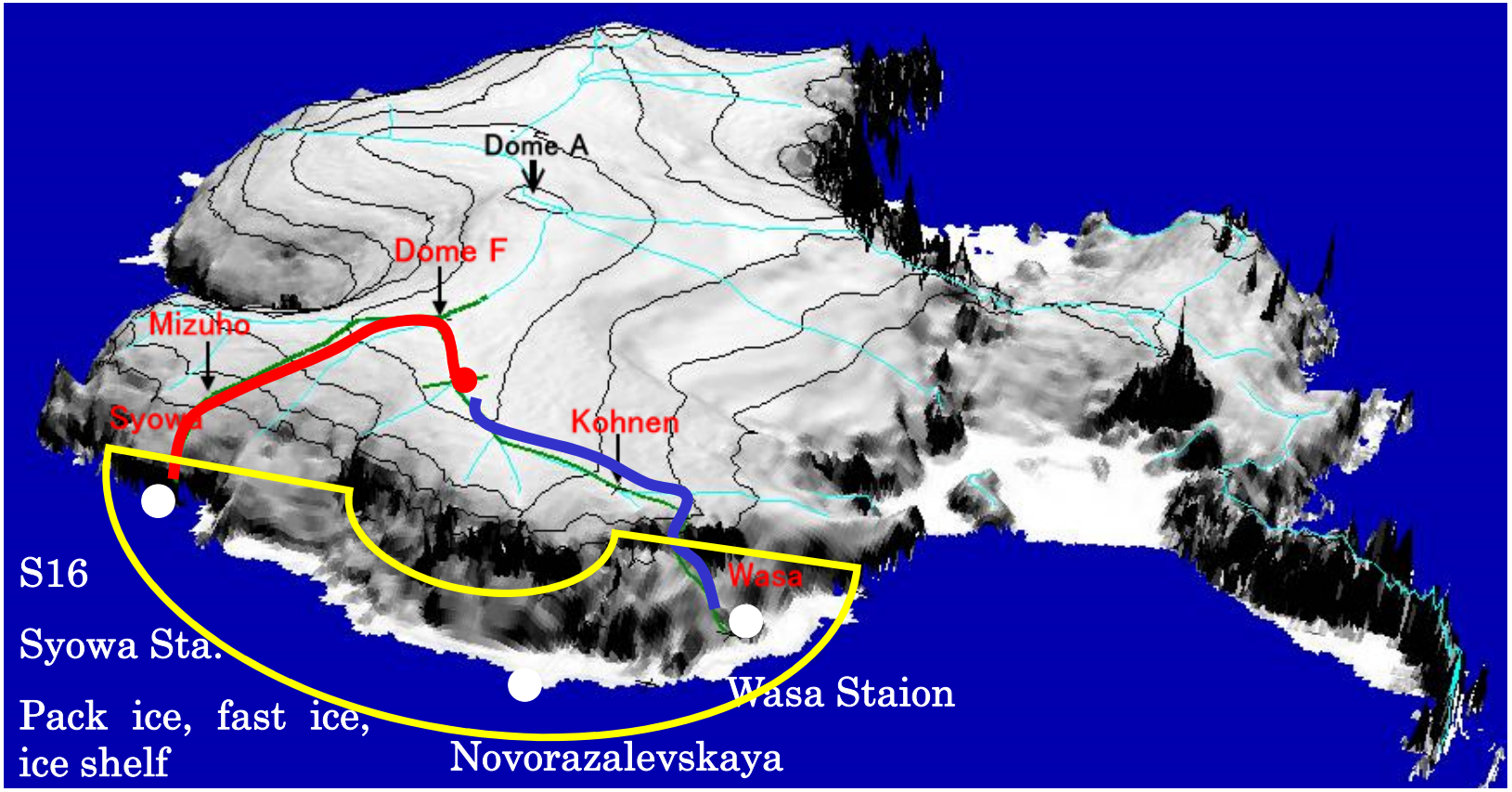
Warm day over Syowa-ice shelf zone 2010/1/9

Microwave emission from ice shelf show year-by-year variation melting





Field Observation Area



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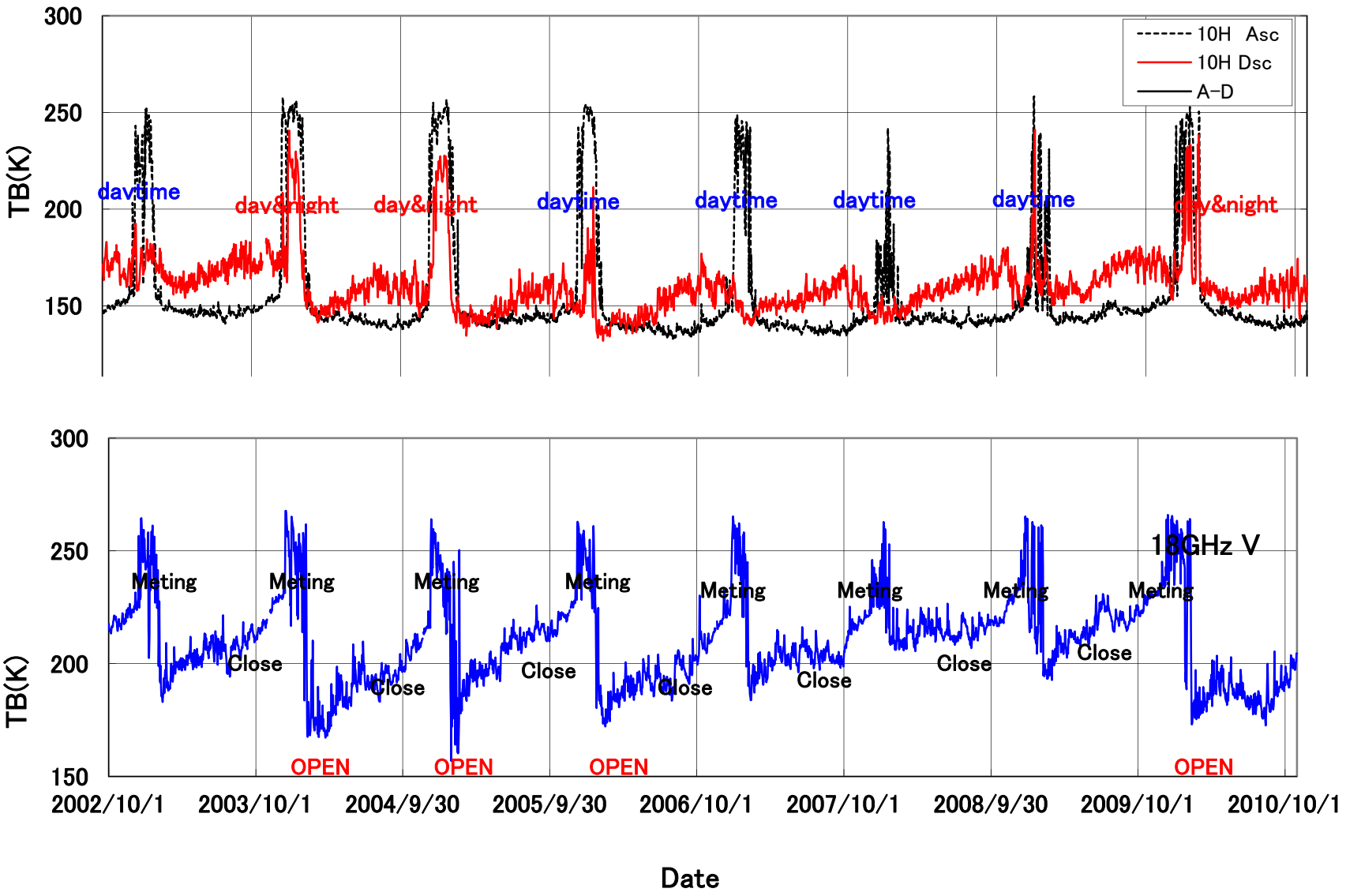
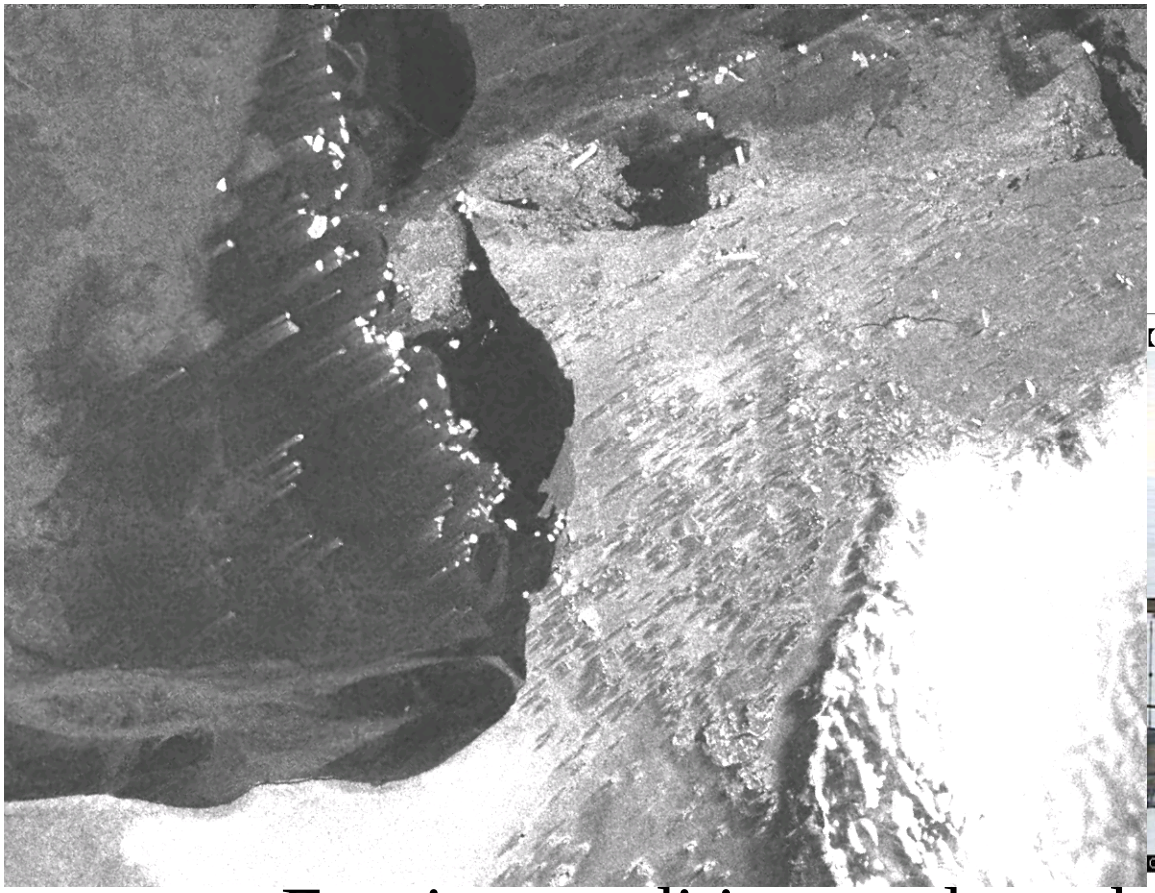
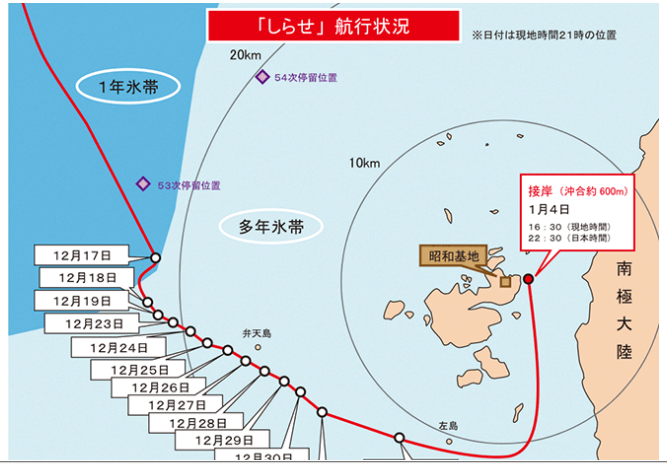

TB 70S 30E
300
250
200
150
TB(K)
10H Asc
10H Dsc
A-D
daytime
day&night
day&night
daytime
daytime
daytime
daytime
day&night
18GHz V
Meting
Close
OPEN
2002/10/1
2003/10/1
2004/9/30
2005/9/30
2006/10/1
2007/10/1
2008/9/30
2009/10/1
2010/10/1
Date

JARE News Jan 4, 2014

http://www.nipr.ac.jp/





【天測点カメラ】

Fast ice condition: no large break-up recently

6m multi-year ice and 2m snow

early season: outer pack-ice zone – late season: melt pond

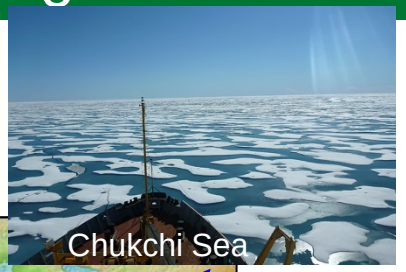
Monitoring break-up and surveying easy route

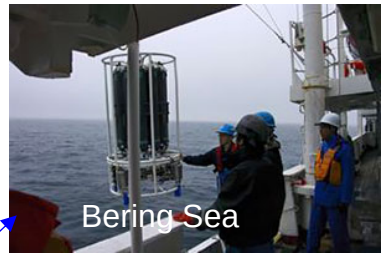
GREen Network of Excellence Program
Arctic Climate Change Research Project
2011-2016

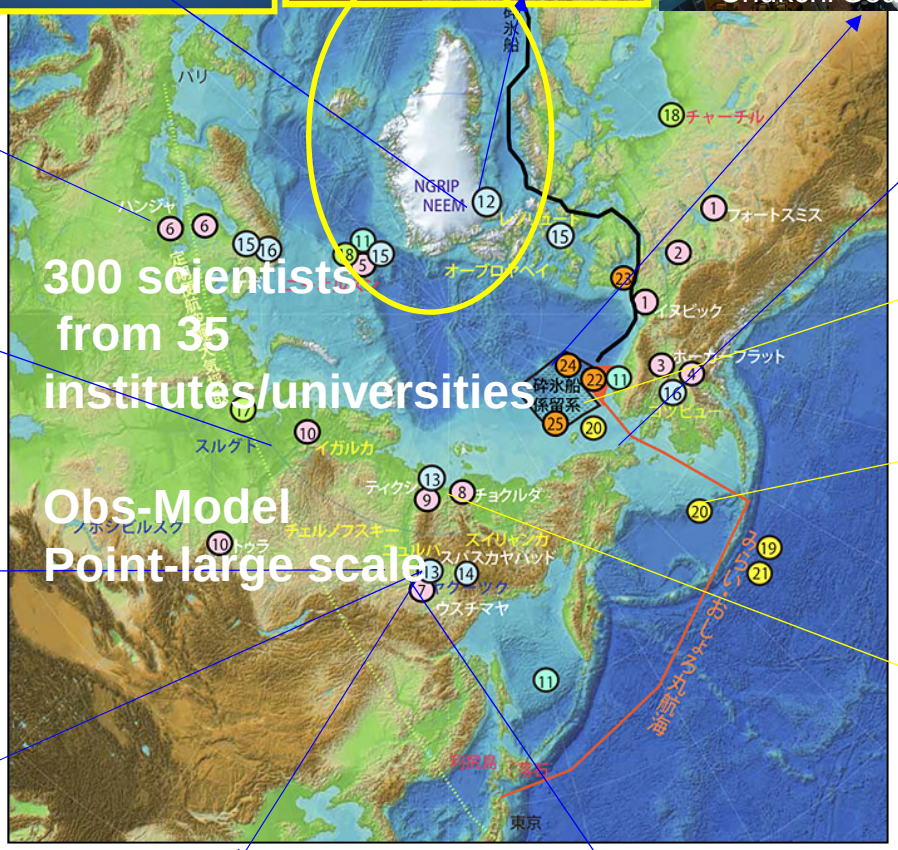
"Rapid *Change of the Arctic Climate System and its Global Influences*"

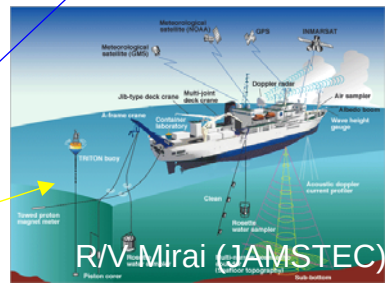
Ministry of Education, Culture, Sports, Science and Technology (MEXT),
NIPR: the core Institute, JAMSTEC: supporting institute,
with 300 researchers from 35 universities and institutions.

Observation / GRENE Arctic Clime Change Research Project



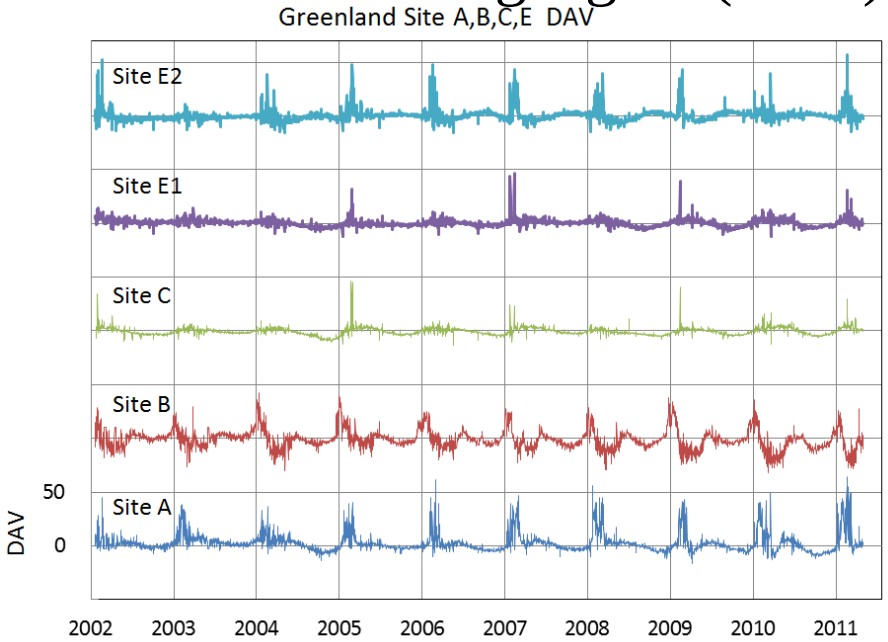


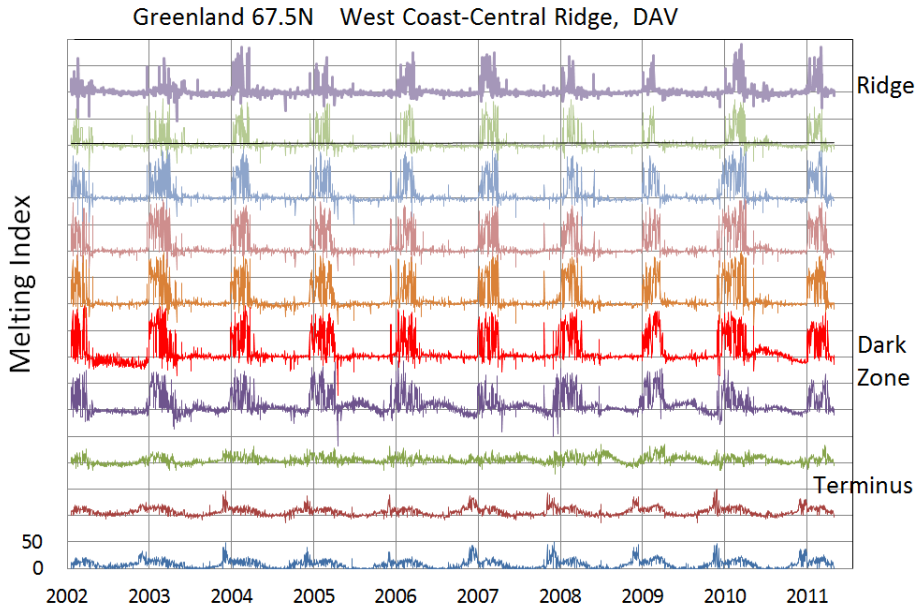




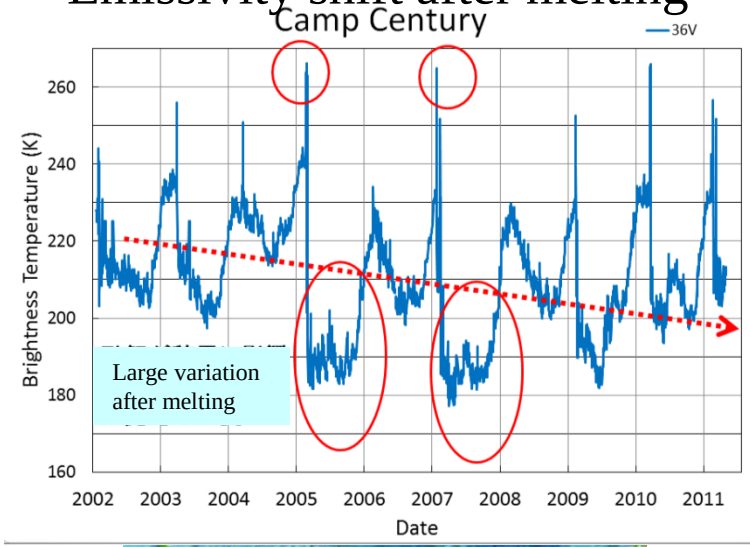
http://www.nipr.ac.jp/grene/kansokudayori/index.html

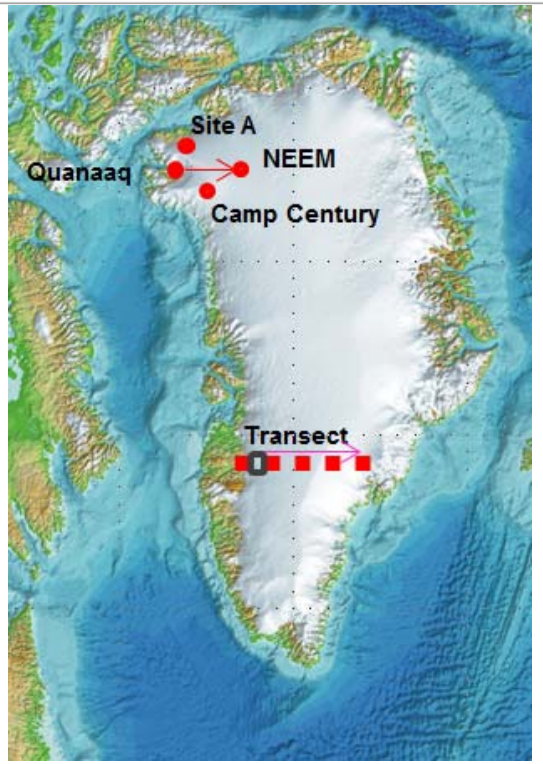
Surface melting signal (DAV)

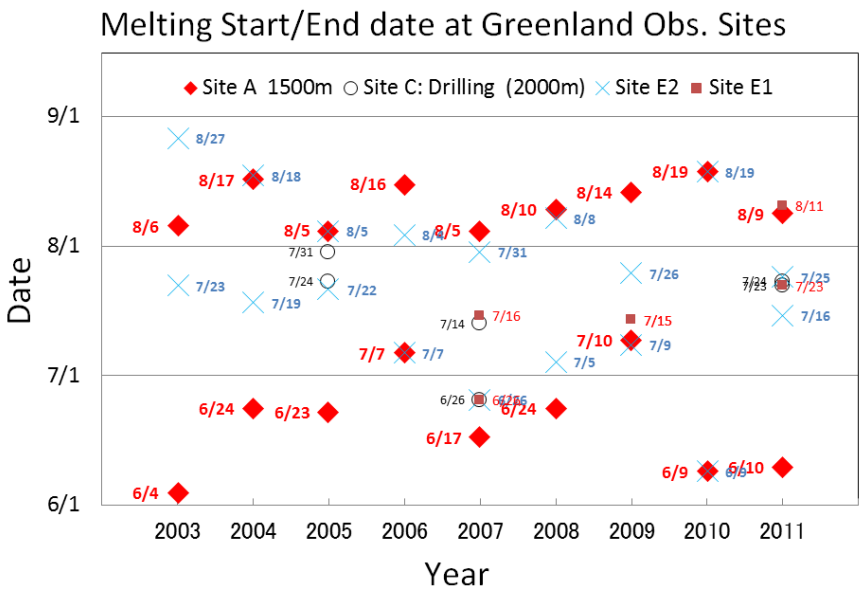


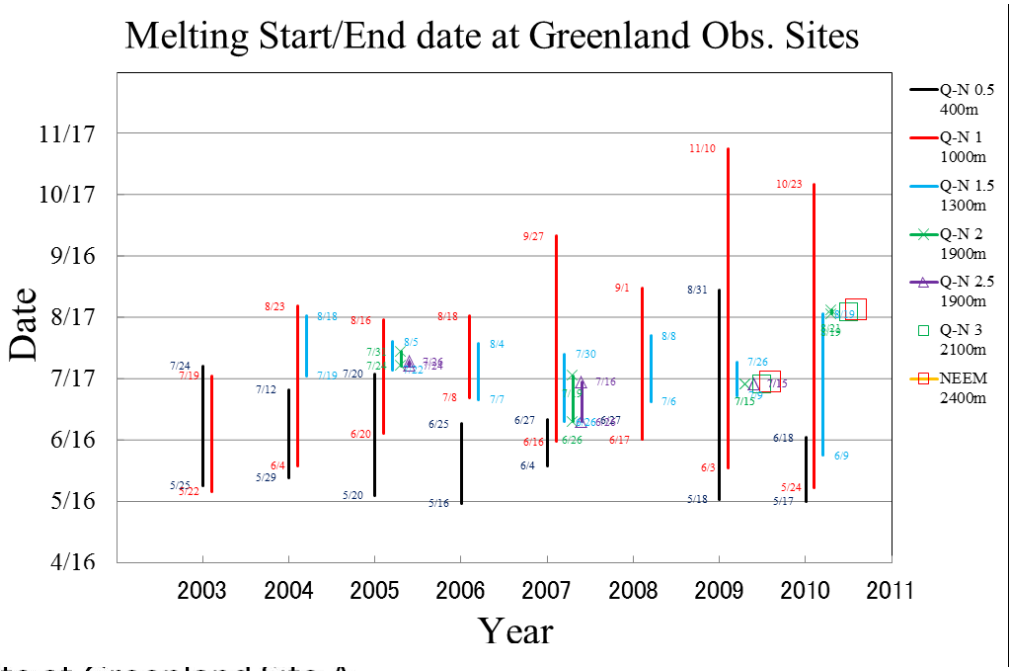


Emissivity shift after melting



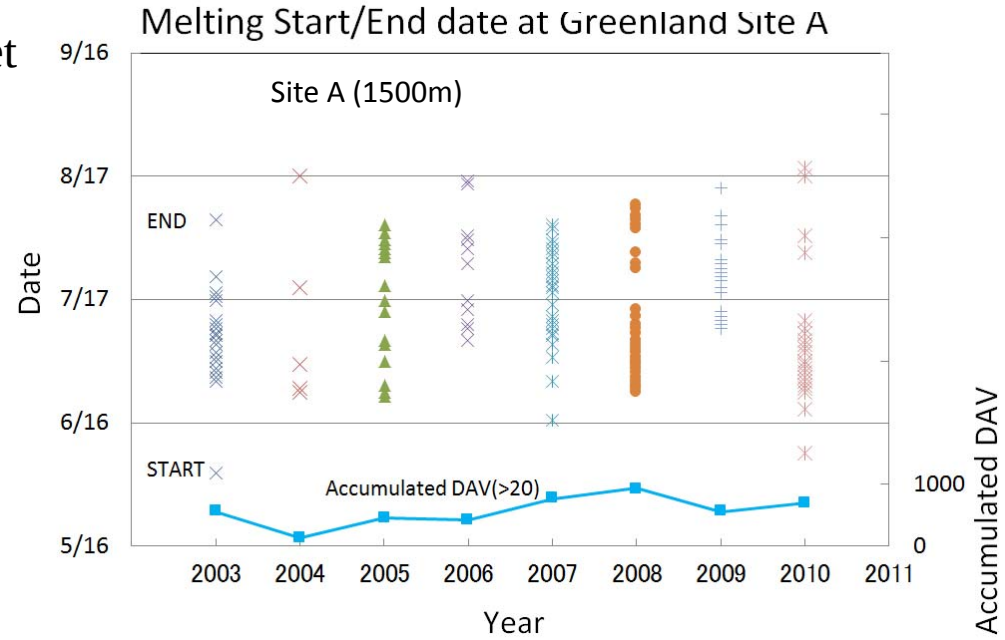






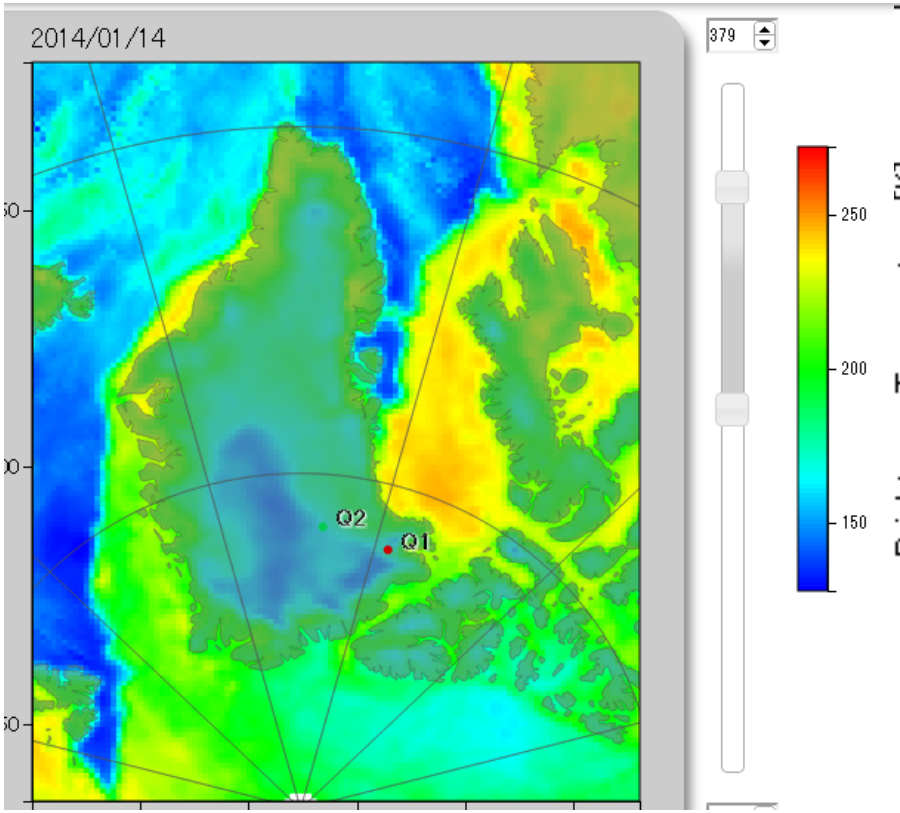
Greenland Ice sheet Observation area

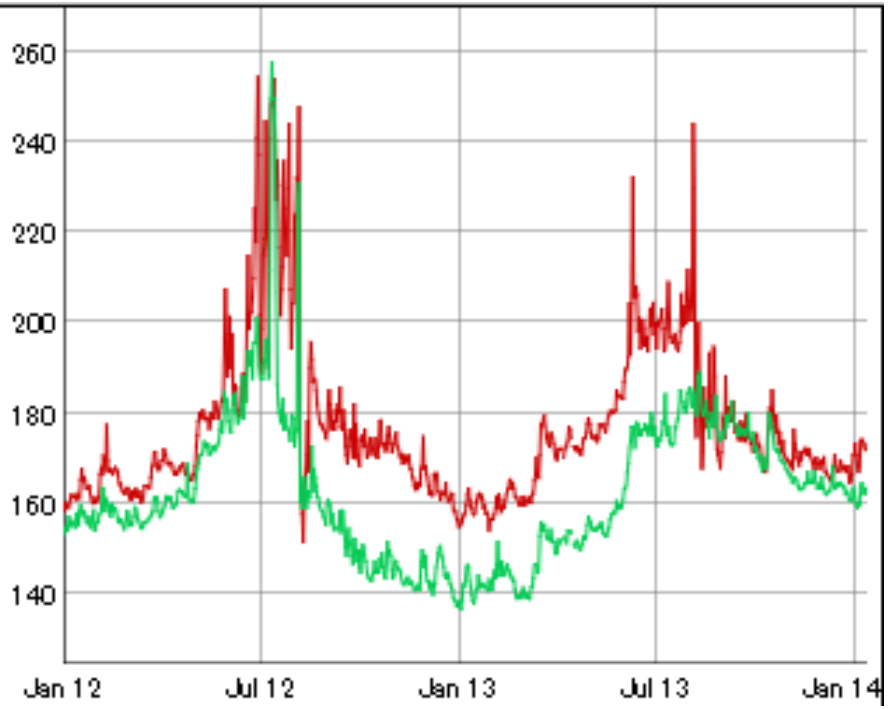
Melt water and coastal outlet glacier dynamics



Temporally Sporadic occurrence of regional melting

NRT observation





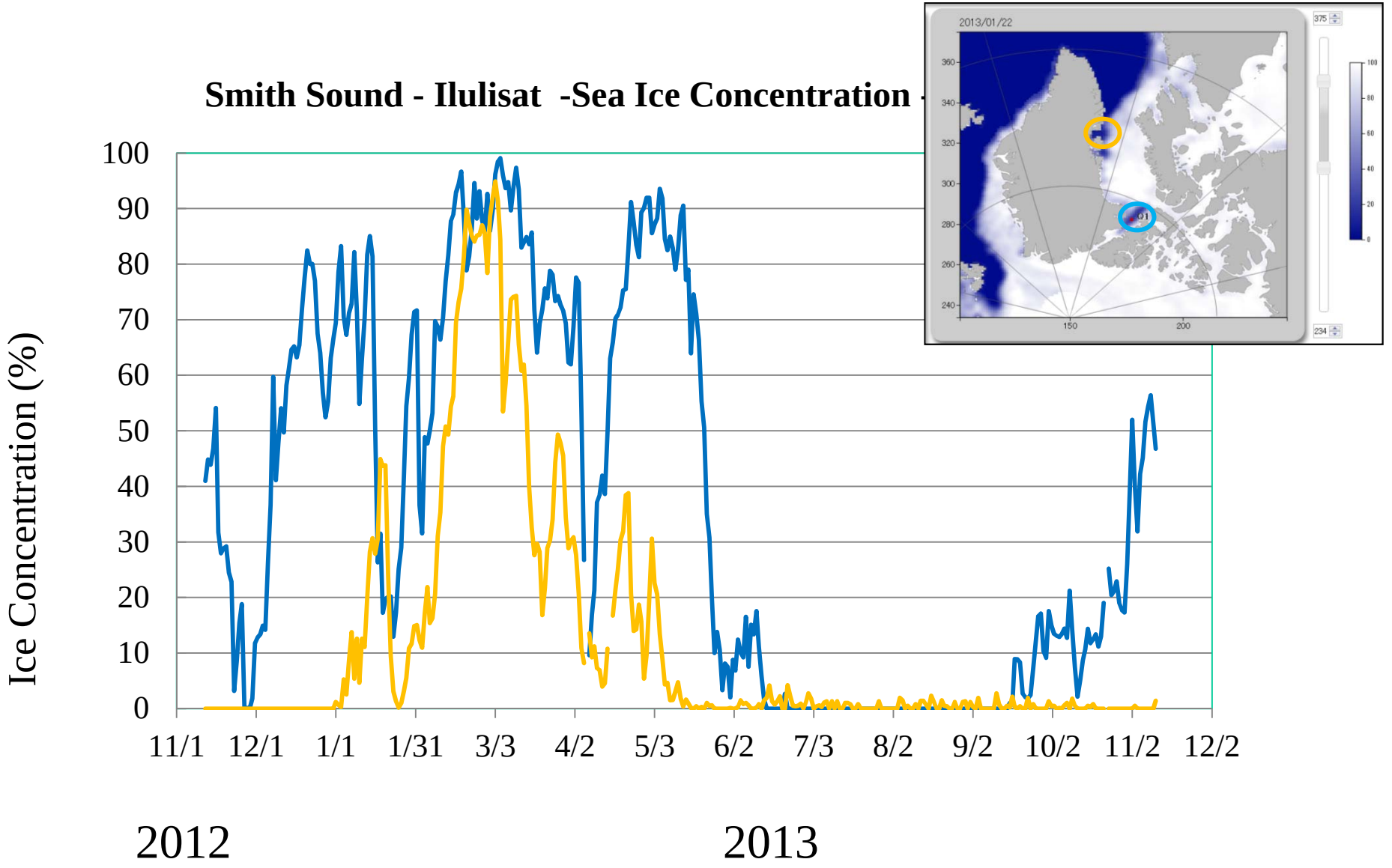
Greenland Ice sheet

Observation area

2012 & 2013 summer
36GHz H SSM/I

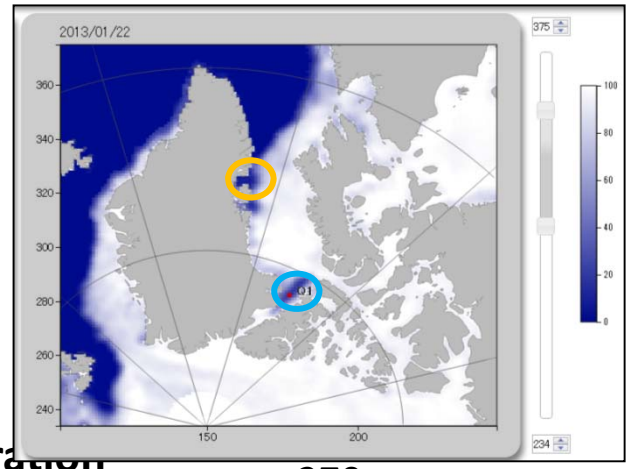
Extreme conditions
2012 warm /2013 cold

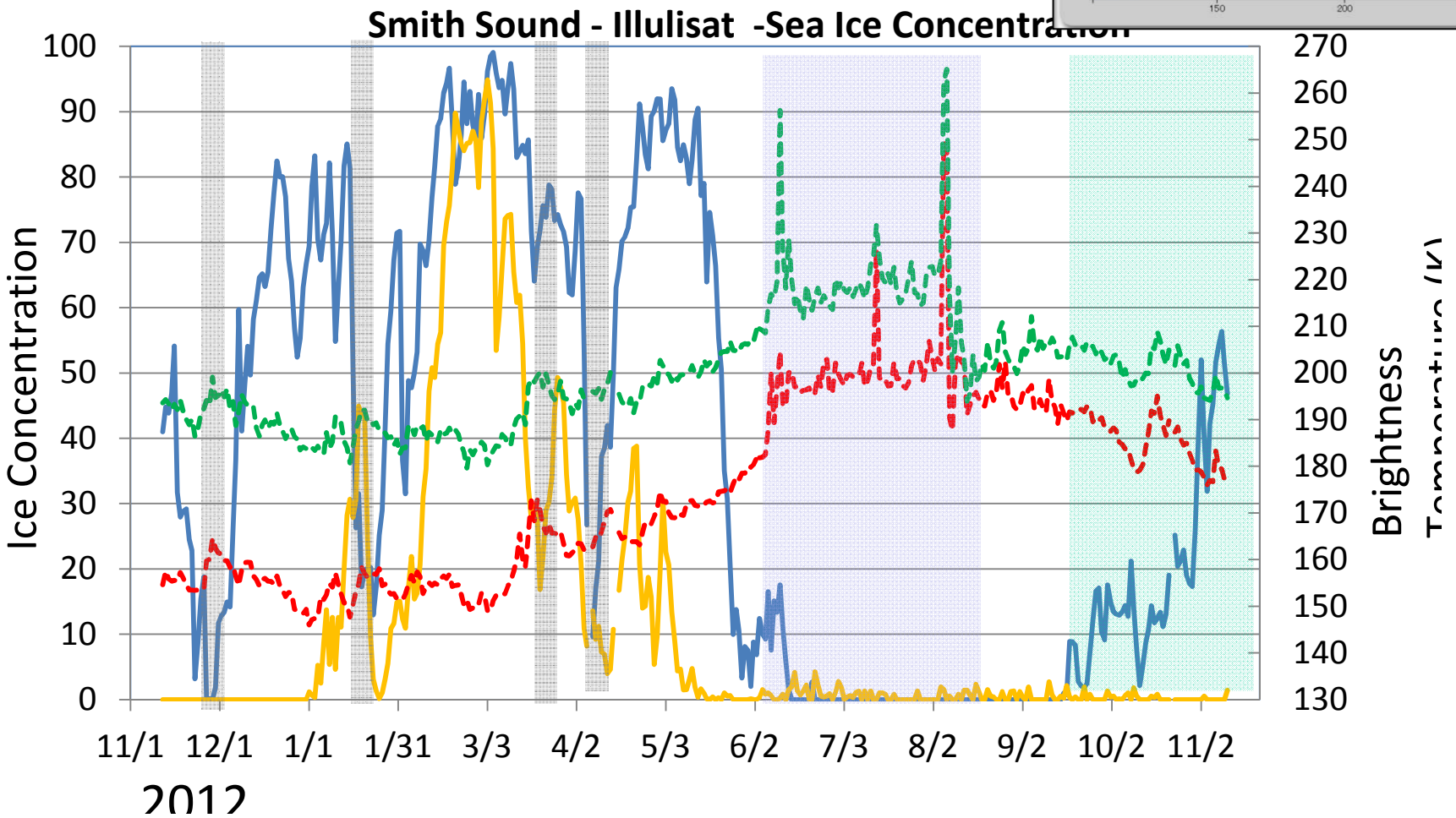
Ice Sheet and surrounding area
Large/regional; scale and seasonal change



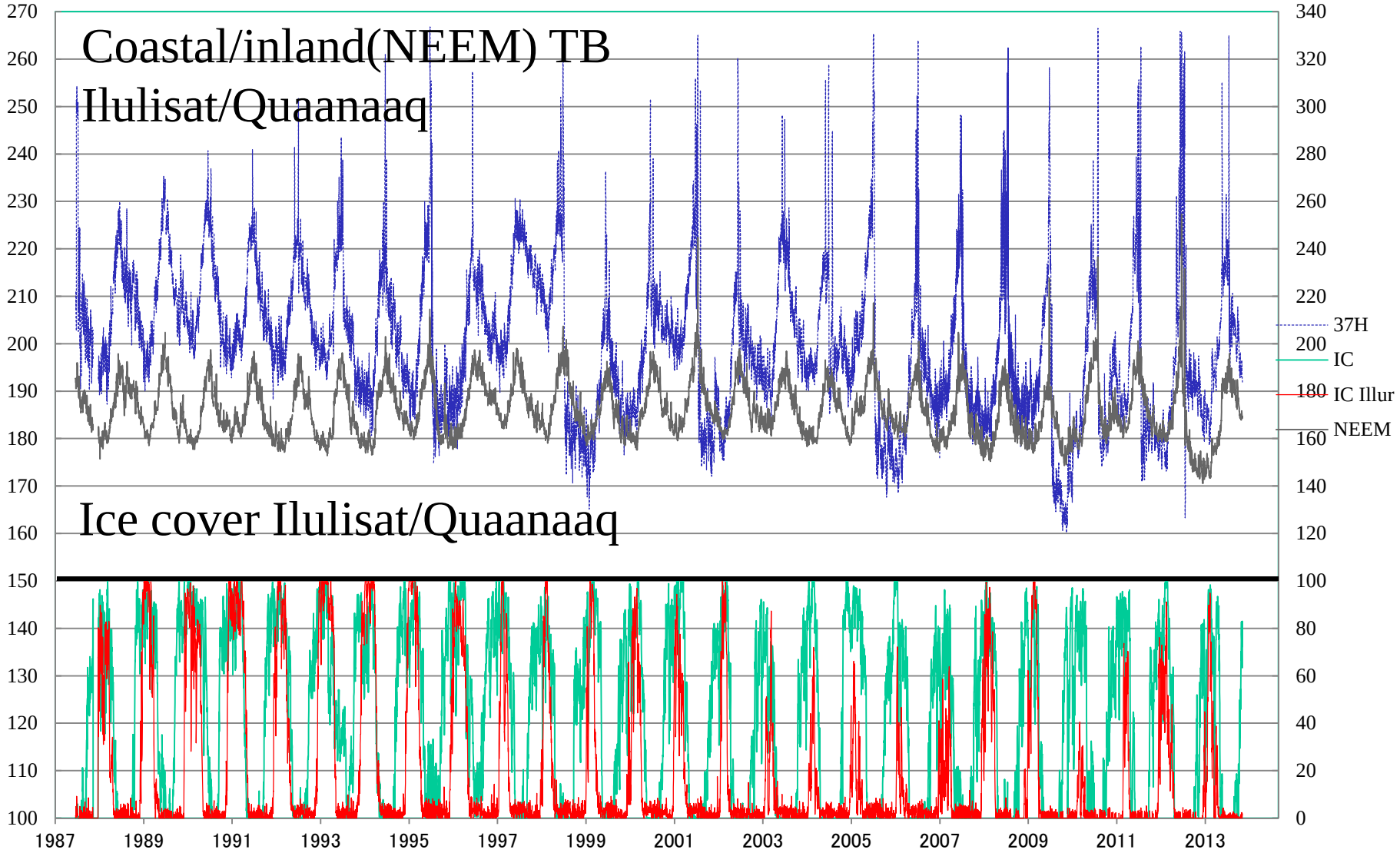
Greenland Ice Sheet and surrounding conditions

Large/regional scales and eventual/seasonal change





Long-term tendency (SMMR-SSM/I) and detailed updated explanation (AMSR-E,2)



Greenland Ice Sheet Research - Arctic Climate Change Study

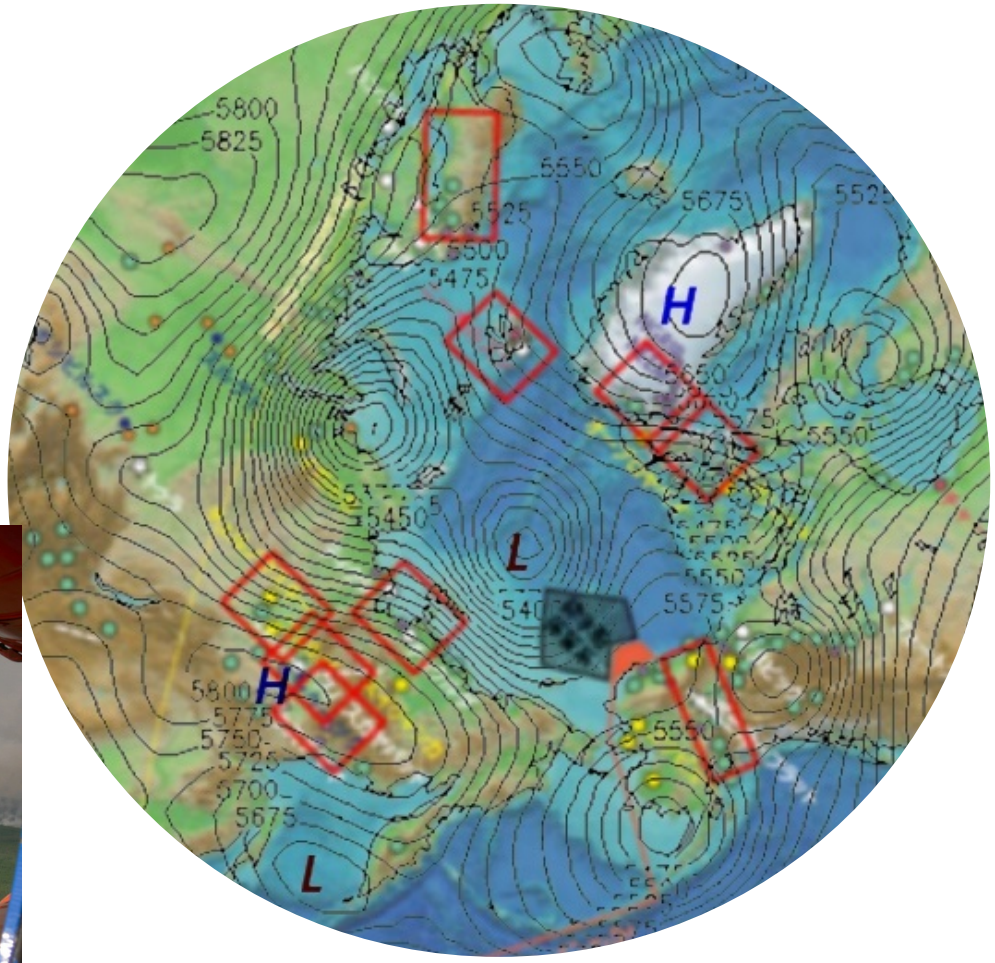
2012 July Greenland melting and other local events

Warm and dry Siberia, Cool Alaska,

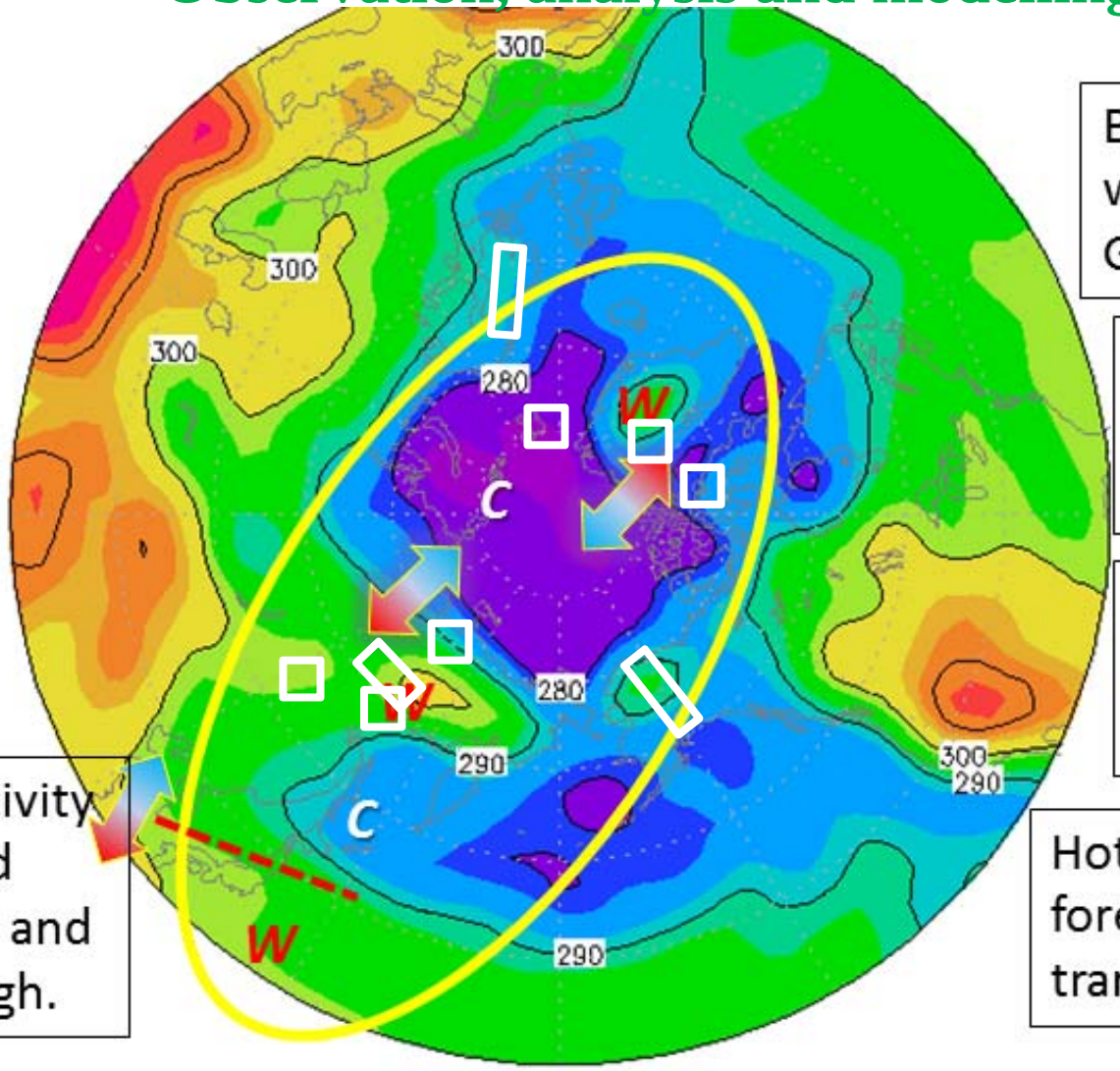
Local weather / Synoptic/ hemispheric scale

NASA, JAXA Report on Greenland melting

Warm, dry summer Siberia



Actic Cryosphere and weather pattern
Observation, analysis and modelling



Blocking and warming over Greenland

Instable northern Greenland weather

Temperature gap and cyclone along Siberian coast.

Hot and dry Siberia , forest fire and BC transport to glacier

Monsoon activity between cold Okhotsk high and hot Pacific high.

Summary

1. Japanese Antarctic Research Expedition (JARE) is monitoring and surveying ice sheet conditions, and studying their changing mechanism.
2. GCOM-W data is useful for large scale and continuous monitoring in the changing climate. Temperature, accumulation, surface conditions ansd melting.
3. GRENE Arctic climate research project (2011-2016) has started by integrating Japanese scientific activities.
4. This project start observation in Greenland Ice Sheet, focusing instability of coastal outlet glaciers.
5. The Arctic project enhances interdisciplinal study and collaboration between modelling and observation. Information and scale-upping by satellite is very important.